AGARD-AR-361

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ADVISORY GROUP FOR AEROSPACE RESEARCH & DEVELOPMENT
7 RUE ANCELLE, 92200 NEUILLY-SUR-SEINE, FRANCE

AGARD ADVISORY REPORT 361

The Prevention of Aircraft Accidents through the Collection and Analysis of Human Factor/Aeromedical Aircraft Accident Data

(la Prévention des accidents d'avion par la collecte et l'analyse de données d'accidents facteurs humains/aéromédicaux)

Papers and discussions from the Aerospace Medical Panel Working Group 23. This Advisory Report is sponsored by the Aerospace Medical Panel of AGARD.

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North Atlantic Treaty Organization

Organisation du Traité de l'Atlantique Nord

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The Prevention of Aircraft Accidents through the Collection and Analysis of Human Factor/Aeromedical Aircraft Accident Data

(AGARD AR-361)

Executive Summary

The Aerospace Medical Panel (AMP) of the Advisory Group for Aerospace Research and Development (AGARD) convened Working Group 23: The Prevention of Aircraft Accidents through the Collection and Analysis of Human Factors/Aeromedical Accident Data. The overall goal was improved application of human factors analysis to operational enhancement and mishap prevention programs. Human factors account for an increasing proportion of overall accidents rates as those due to mechanical causes have steadily declined. NATO human factors data collection techniques were reviewed in order to recommend a common framework for future collection of human factors data. Decreased flying hours and a fall in the overall numbers of accidents have increased the need for pooling data internationally to allow the early detection of accident/incidence trends. A common data base will provide a capability for valid statistical analysis.

Topics discussed included:

- A general review of the current status and approaches to aircraft accident/incident investigation among the various NATO nations.
- Current status of accident investigation and human factors training in NATO.
- Current status of procedures for categorization, tabulation and analysis of accidents data.
- Results obtained from questionnaires distributed among all NATO countries.
- Major accident rates among NATO countries (1990-1995).
- Discussion of possible approaches to the collection and analysis of human factors data.
- Principles and description of the basis for a human factors/aeromedical data base.
- Future training and education options.
- Examples of data bases currently in use.

The outcome of Working Group 23 is this Advisory Report which addresses these issues and recommends the following items:

- A common human factors framework and taxonomic schema needs to be developed.
- Due to National differences in data collection methodology, second level coding of accidents may be needed to achieve a common data base.
- Need for a forum to exchange lessons learned and current trends within the NATO human factors specialist community. Data exchange with civilian agencies should also be promoted.
- Human Factors training for aircraft accident prevention needs more attention and a model course syllabus should be established among NATO specialists such as flight surgeons, psychologists, physiologists, ergonomists and aircrews.
- Further research should be done in taking into consideration the approaches outlined in this document.
- Evidence gained from flight simulators, incidents, confidential aircrew reports etc. should be utilized to allow pro-active preventive measures.

La prévention des accidents d'avion par la collecte et l'analyse de données d'accidents facteurs humains/aéromédicaux

(AGARD AR-361)

Synthèse

Le Panel de médecine aérospatiale du Groupe consultatif pour la recherche et les réalisations aérospatiales (AGARD/AMP) a réuni le groupe de travail No. 23 sur "La prévention des accidents d'avion par la collecte et l'analyse de données d'accidents facteurs humains / aéromédicaux". Ce groupe a pour objectif principal une meilleure application des résultats de l'analyse des facteurs humains aux programmes liés à l'efficacité opérationnelle et à la prévention des accidents. Les facteurs humains sont à l'origine d'un nombre toujours plus élevé d'accidents d'avions alors que les causes mécaniques sont en diminution constante. Les techniques de collecte des données relatives aux facteurs humains utilisées par l'OTAN ont été étudiées pour trouver une ligne de conduite commune pour la collecte de ces données à l'avenir.

Avec la diminution des heures de vol et la réduction du nombre d'accidents, la mise en commun des données au niveau international devient de plus en plus nécessaire afin de permettre l'identification en temps utile des différentes tendances accidents/incidents. Une base de données commune permettrait de faire des analyses statistiques poussées.

Sujets examinés:

- examen de la situation actuelle et des orientations adoptées dans le domaine des techniques d'investigation des accidents/incidents d'avion
- état actuel des techniques d'investigation d'accidents et prise en compte des facteurs humains au sein de l'OTAN
- état actuel des procédures de catégorisation, de mise en ordre et d'analyse des données d'accidents
- résultats obtenus par les questionnaires diffusés à tous les pays membres de l'OTAN
- principaux taux d'accidents dans les pays de l'OTAN (1990 - 1995)
- discussion des approches possibles de la collecte et de l'analyse des données facteurs humains
- principe et exposé de l'intérêt d'une base de données d'accidents facteurs humains/aéromédicaux
- possibilités de formation et d'enseignement
- exemples de bases de données existantes.

Ce rapport consultatif, qui est le fruit des travaux du groupe de travail No. 23, examine ces questions et fait les recommandations suivantes:

- un cadre de référence commun pour les facteurs humains doit être développé, ainsi qu'un schéma taxonomique
- en raison des divergences constatées entre les pays membres en ce qui concerne les méthodologies de collecte de données, un deuxième niveau de codage des accidents pourrait s'avérer nécessaire afin de garantir la concordance des données
- un forum doit être créé pour l'échange des enseignements et des tendances actuelles au sein de la communauté des spécialistes OTAN en facteurs humains. Des échanges de données avec les agences civiles doivent également être encouragés
- une attention particulière doit être portée à la formation en matière de prévention d'accidents d'avions à l'aspect facteurs humains. Un support de cours type doit être établi par les différents spécialistes de l'OTAN tels que les médecins de l'air, les psychologues, les physiologistes, les ergonomes et les équipages
- il y a lieu d'entreprendre des travaux de recherche plus poussés, en tenant compte des approches définies dans ce document
- les éléments d'appréciation obtenus grâce aux simulateurs de vol, aux incidents, aux rapports confidentiels des équipages etc... doivent être utilisés pour promouvoir par anticipation des mesures préventives.

Contents

Preface

Human factors are involved in the majority of the aircraft accidents and incidents as a primary causal element. In September 1992, representatives of all countries in AGARD conference 532, Aircraft Accidents: Trends in Aerospace Medical Investigation Techniques, agreed with Dr. Levy's conclusions and recommendations in order to improve the man-machine interface and reduce error accidents.

Main emphasis was made to determine why the accident occurred and how to properly conduct an investigation, considering, as a whole, aircraft, design, operational procedures, aircrew, ground crew, training, physiological psychosocial and psychological factors influencing personnel involved in the chain of events leading to the accident.

Aircraft accidents can be seen as the most extreme form of failure in flight safety work, the human factors involved should be carefully analyzed in order to add them to a common bank of experience in the NATO community. There is a need for establishing a discrete record, as complete as possible, standardized and including information of all personnel causally involved in the accident. As a result, better compatibility and comparability between different databases will be possible.

Working Group 23 believes that a united collection of human factors data could be used to analyze human error and perform meta-analysis of all occurrence reports. Such a database would contain uniform human factor information for comparison and statistical analysis. This system is essential to validate or refute association between related factors and detect trends or tendencies.

Research results could be made available quickly to aid current investigations and assist development of new aircraft systems.

The result would be a greater understanding of the role of human factors in accident causation, better education in human factors in general and improved investigation training.

In 1993, a proposal for a working group was made by the Biodinamic subcommittee of AGARD-AMP under the original title of "Database Collection in Aircraft Accident Investigation," but final approval of the so-called WG23 did not happen until 1994. The scope of WG23 was the development of an Aircraft Accident Human Factors data base analysis capability that would provide valid statistical association and development of a NATO training program for accident investigators, both with an operational application of HF analysis to a program of prevention.

So far, we knew that investigating and collecting data in the NATO community is a problem not completely resolved, but very little was known about details referring to the management of the investigation, classification of accidents, average number of accidents, protocols, and a list of questions never before surveyed country by country.

We found it imperative to know the real pulse of the aircraft investigation status in all NATO countries and, accordingly, we sent a survey of twenty questions which, in fact, validated the need for WG23.

The first meeting took place in Brussels where topics were designed, survey questionnaire finished and distributed, and final title of the working group was determined according to the topics involved.

The second meeting took place in Cologne. There, the first draft of the chapters were reviewed and discussions focused on the coding and usefulness of a second level data base. We agreed that a NATO consensus on a large data collection format would not be possible and a smaller and more analysis-intensive database could be developed to track and identify NATO high interest areas. Colonel K. Magnusson replaced Colonel Richard Levy as a member of the working group, due to the forthcoming retirement of Dr. Levy.

The third meeting was set for Albuquerque, New Mexico, home of the USAF Flight Safety Center. Throughout the meeting, we reviewed drafts of all chapters, with special emphasis dedicated to the database collection issue. A final structure of the chapters was designed.

The last meeting in conjunction with the AMP symposium in Copenhagen, was dedicated to a final review and corrections of the document.

Throughout the meetings and subsequent discussions, it became clear that the final product of this WG must be a reference document for the accident investigator and not necessarily only for the flight surgeon, but also for the psychologist, human factors rate officers or any other member of the investigation team.

From that perspective, we set the document in four main areas, a general scope of the problem, the basis for a data collection, the tools for collecting the most appropriate data and finally we reviewed the training we should provide to the future investigators.

Any aircraft lost means a significant event, whether due to the cost of the aircraft, or loss of experienced personnel. But the weak part of the envelope by any means is the human being. Collection of data and a common repository is a difficult task according to the variety of methods currently in use among NATO countries. But the main problem is to stress the importance of the data collected by the investigator throughout the course of the investigation. It must be detailed, accurate and complete. That means a final document that is designed in a wide variety of forms, written-narrative report, item computer developed or mixed. Key point of the document is the contents, including all the facts and mechanism leading to the accident. It has been the objective of this document to create the basis for a framework of human factors for further collection.

Systems to analyze the information are ready available, but must contents the adequate information.

If this framework of human factors becomes currently in use in NATO, a common language of human-related factors will be used for loading the same occurrences into a common database, and a great potential resource of information will be ready for analysis, and further recommendations fully extensive to those countries which load similar events or occurrences.

The goal of every flight safety officer is to prevent accidents. Our goal is to provide the best analysis possible from the collection of human factors data of occurrences in order to prevent future accidents. A pooling of NATO human factors data for analysis would greatly increase the validity at timeliness of the identification and application of human factors countermeasures to the operational flying community.

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CHAPTER I

INTRODUCTION

Human factors are involved in the majority of the aircraft accidents and incidents as a primary causal element. On average, two-thirds of aircraft accidents are human factors related. Jensen defines Human Factors as follows: The field of science concerned with optimization of the relationship between people and the machines they operate through the systematic application of human sciences integrated within the framework of systems engineering. Working Group 23 considers human factors also to include biologic and physiologic factors, as well as psychologic factors (5). Transition from the era of mechanical failure to the era where machines are more reliable and safer, but very demanding in areas such as judgment, decision making, mission accomplishment and workload lead to conditions where the weak link is the human error. This is even more relevant in military aviation where new airframes mean a significant cognitive workload to the pilot and frequent requirements for a very limited reaction time. Tasks are varied and demands are increasing during a period when training and flying time is decreasing. Modern military aircraft are conceived as a flying platform capable of carrying a substantial amount of computer controlled weapons, supported by a very complex set of avionics, electronics and software. A single aircraft accident represents significant loss, due to the loss of human life and the costs entailed by loss of an aircraft and the expertise, training accumulated and skill of the crew.

In 1993, ICAO in the circular 240-AN/144 pointed out the need for adopting a uniform approach to the investigation of Human Factors in Aviation occurrences. It is also recognized that while most investigations determine the "what" and "when" quite effectively, the "hows" and "whys" are often incomplete or lacking. The need for a more rigorous epidemiological study of the human factors causes of aircraft accidents has been recognized (2). The need for a broader database has been identified as a problem in accident epidemiology (3,1). There exists currently a myriad of different databases; Murphy and Levendoski described 34 different aviation safety databases, including military, governmental agencies, aircraft manufacturers, airline companies, special interest groups, and international agencies. In 1985, the National Transportation and Safety Board (NTSB), the largest U.S. civil database contained 108,000 accidents or incidents and was adding mishaps at the rate of 3,000 per year. Several limitations of this database were noted as due to limited resources, complete investigations were limited mainly to accidents involving commercial air carriers and the wording of conclusions was cautious as these could be used subsequently in litigation (3). In 1985, the USAF Safety Center database contained approximately 500,000 records of accidents or incidents and was being added to at the rate of 3,500 - 4,000 per year. A major limitation of the USAF database was stated to be that Life Sciences results were not able to be released (3). By way of comparison, the ICAO database in 1997 contained 18,678 accidents with 750 - 800 being added per year, and the contains only limited human factors information. In addition, it is limited by the variable quality of the reports from different member states, by translation difficulties, as well as by differing case definitions, coding schemes, etc. (3). Generally, these databases were designed individually to suit the purposes of a given organization and interoperability between databases was generally not a consideration in the design. Consequently, these databases use unique data fields and the capacity to exchange data is limited and Murphy recommended working to establish a "master database" (3). The U.S. Federal Aviation Authority (FAA) has proposed a Global Analysis and Information Network (GAIN) with the aim of establishing an international network for sharing and analyzing safety information (4).

Recognition of the need for more rigorous epidemiology and the limited number of accidents experienced by each individual NATO nation prompted AGARD to recommend a combined NATO database for safety/human factors (1). In September 1992 at the AGARD conference Aircraft Accidents: trends in aerospace medical investigation techniques, representatives of all countries restated these facts (1). The delegates agreed in particular that

there existed a need for a broad Human Factors Database that would be accessible to every NATO country. Such a database would contain uniform human factors information for comparison and statistical analysis. The result would be greater understanding of the role of human factors in accident causation, better education in human factors in general and could lead to improved investigation training.

Thus, WG 23 was formed. Its first task was to glean a picture of what was actually being done in each country in terms of investigation and what existing database was used. A questionnaire was developed and 11 countries out of 14, with responded. France and the United States provided separate responses for the Air Force, Army and Navy. The results of this questionnaire can be found at annex B. Most countries agree there is a need for a human factors database that offers interoperability between NATO countries.

The main objective of this project was to define a common framework for investigating, reporting, collecting, and analyzing human factors data to create a common database with access to users from all NATO countries. The advantages of such a database are clear from a statistical point of view; single events in one country could be matched to similar events on similar aircraft types in other countries and, thus, increased sample size with improved precision could result. Advantages in research, development and education could also benefit from this common database. The following chapters offer a means of achieving uniformity in the collection and interpretation of human factors data, as well as the problems likely to be encountered in the creation of such a database. It also offers short-term and long-term options for the institution of a common database and discusses training and education options.

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CHAPTER II

APPROACHES AND ANALYSIS FOR THE COLLECTION OF HUMAN FACTORS / AEROMEDICAL AIRCRAFT ACCIDENT DATA

Introduction

Since the sixties, databases have been incontestable tools for all socio-technical organizations wanting to improve the safety of their production systems. Databases are used to support the collection and analyses of relevant information so that we can better understand and prevent incidents and accidents. Designers were first to systematically use databases to assess and calculate tool technical reliability. Databases allowed the reliability engineers using failure tree analysis to attribute failure rates to branches of the tree. In complex systems such as aeronautical or nuclear power plants, the results were so successful that reliability engineers rapidly established the idea that the human operator was the weak link and not the machines. Engineers then began to consider the human operator as an unreliable element within complex systems. Consequently, they decided to use the same reliability techniques to measure human reliability. For these reasons, human factors databases became systematically more useful. Results from the first human factors databases gave engineers a better understanding of human frailties. With this information, they were able to make significant improvements in safety. However, the limitations of these databases became increasingly apparent once comparisons were made. These limitations can be summarized by the following assumption: it is easy to model technical systems or architectures; on the other hand, it is much more difficult to model human behavior. As a matter of fact, our knowledge of medicine and physiology is fairly well-developed, conversely our understanding or validity of psychological principles is limited and much less developed or understood. For instance, many behaviors are not fully understood, much less correctly described. Consequences of these limitations are a lack of standardization in the collection and formalization of human factors data.

Preliminary Comments on Human Factors Database Use

In spite of increased interest in human factors databases, certain comments regarding their use must be stated.

First, the success of a human factors database is often assimilated to computer capacity. In effect, databases are continuously installed on more powerful computers making it much easier and faster to extract and exploit vast amounts of information.

Second, the ability to exploit human factors databases is directly associated with operator's level of competency in human factors and computer science. In the past, computers were used only by experts. Today, the proliferation of micro-computers with "user friendly" software and interfaces has enhanced accessibility to what were once complex databases.

Third, computer networks have given the users access to a tremendous amount of readily available data. These computerized work stations enable users to examine and exploit elaborate databases from a single terminal located virtually anywhere in the world. Whereas centralized systems were once managed by one or two experts, the relational network databases of today are tailored to specific organizational and managerial requirements and rules.

Such developments are very attractive but may lead to confusion:

- Despite the overwhelming availability of data processing tools, the relevance of interrogating databases depends more on the availability of valid data than on processing power. In other words, the users should understand the nature of the data used in the database and not get carried away with what may be a "technological mirage."

- The nature of the information obtained from a database is only as good as the

interrogation. Databases only give responses to questions they were designed for. This means databases are not universal and, as a result, cannot respond to certain problems insofar as these problems were not considered during the design phase. Databases change relatively slowly, whereas the problems they were meant to address have a tendency to evolve quickly. Consequently, databases will become more limited if they are not periodically updated. This last point concerns the generality of the data collected. The more general the data collected, the more pertinent its use and vice-versa.

Databases and Data Transformation

A database is a tool, used to store data in an organized fashion making it easier and faster to extrapolate information from the original raw data. By using this apparent definition of a database, one introduces the concept of information coding. In effect, in reality, data which characterizes one aircraft accident are complex and have multiple temporal and spatial relationships. When an investigation board investigates and collects data, in a report it describes the accident in terms of a linguistic code. Eventually, the investigators may be able to use the spatial-temporal relationships to help understand the facts of the accident, but generally speaking, they are limited because of the complexity of the data. Sometimes, the final report may use spatio-temporal representations (photos, drawings, schemes, etc.) to help understand the facts, but these representations are generally limited when compared to the complexity of reality. In writing the accident report, investigators use a coding process insofar as the real data are transformed into this linguistic code. Such a coding process is subject to three mechanisms that modify the nature of the data into a new code:

- the meaning of the information is modified because the investigation board has to interpret the data in order to adapt them to the new code,

- some information may be suppressed because it is judged to be nonrelevant or difficult to transform accurately into the new code,

- in generalizing the process, the board may group some to the information under one single heading, therefore reducing the fidelity and accuracy of the data.

Information modification which results from the coding process has a direct effect in that the accident report is a subjective analysis of the situation. This occurs in spite of the accident board's desire to be objective.

To enter data from an accident report, the analyst must process the information from the accident report in the same way as the accident board had originally using another coding procedure. The object is to exploit the database quickly and effectively so that the information retrieved from the report can be interpreted and simplified. Such data processing is the key to the design of a database. The choice of coding used to transform data from the accident report to the database directly defines the capabilities of the database. The problem with designing a "human factors" database is in choosing the method of coding. As implied above, there is no one universal coding system which facilitates a detailed description or explanation of all human behavior. Finally, the models used today may have a limited relevance with respect to problems which will be encountered tomorrow.

"Human Factors" Database Objectives

The objectives of a "human factors" database can be described in two levels:

- a database is a tool used to support investigators collecting "human factors" data.

- a database is a tool used to analyze and explain mechanisms and factors associated with aircraft accidents and incidence. The primary purpose of this second level is that of a preventive tool.

Such a distinction is important because each approach will require a different design of the "human factors" database resulting in the collection of different data.

If the objective is to design a database in support of data collection, designers have to ensure that in using the database, all relevant data has been identified and collected by the investigators.

When using such an approach, the data collected must precisely represent the facts surrounding the accident. In this case, the underlying assumption is that the general data collected from an accident will be transformed using a second step into a detailed description of the circumstances surrounding the accident, consequently the initial data collected must be exhaustive. Within the human factors investigation, information from the following disciplines must be included:

- medicine
- physiology
- psychology
- psycho-sociology
- ergonomics
- macro-ergonomics
- air crew protection (ejection)
- rescue and survival

The difficulty with such "support" databases resides in the fidelity of the data description. If the data description is too accurate, there is a risk of having data that is too specific which could thwart an accurate comparison and analysis with data from other accidents. This results when a database contains data from different aircraft accidents involving different aircraft; particularly, for example, when comparing fighter and trainer aircraft.

Explanatory "human factors" databases evolved as a result of a growing concern in human error in flight safety. These databases are built using descriptive or explanatory models of human behavior. The data are often the result of interpretations made by analysts who are "human factors" specialists. It is for this reason that such databases can be termed "second level" databases. The main weakness of these databases is their temporal validity. When designing these databases, it is assumed that there is a direct relationship with "human error" models. However, our understanding of human error is certainly not definitive and exhaustive models simply do not yet exist. The constant evolution of human error theories over the past 20 years gives us cause to be concerned about the permanence of such models. On the other hand, technological improvements that stand out as milestones in aviation history are not necessarily the same today as they were in the past (for instance, sensory-motor abilities are less important now when piloting fly-by-wire aircraft). In contrast, today's technologies have created new human factors challenges (for instance, transparency and opacity to understand and use automatic mode transitions in flight management systems for glass-cockpits aircraft). Each time "human error" theories are updated, new models must be examined.

The Nature of Data

To understand and analyze human error, the mechanism used to transform aircraft accident data from an inventory of facts and assumptions into a coherent explanation has three levels (14): the behavioral level, the contextual level and the explanatory level. At each level, there are specific "human factors" data.

<u>The behavioral level</u>:

The behavioral level, like the analysis level, is considered the most superficial because the analyst seeks to identify directly or indirectly the erroneous behaviors from information collected during an investigation. The erroneous behaviors consist of acquiring information, psychomotor and communication. The behavioral level is descriptive. The fundamental assumption of this human behavior model labels the human being as the weak link within a system. Consequently, the first analysis of human error was conducted by reliability specialists. This helps explain why such a negative view of the human operator has evolved. Many error classifications have been proposed which would describe the various erroneous human behaviors. One of the most popular was developed by Swain (16). Swain describes 5 types of error: omission, delay, sequence, deviation and execution.

The SHELL (software, hardware, environment, lifeware) model (6), largely used for flight safety, can be likened to the behavioral level. The model describes the risk of man-machine system failure in the interactions between the human being (lifeware), the software, the hardware, and the environment or the other human operators (lifeware).

Other "human error" classifications are more focused on damage and consequences of human error, on the reparable or the

nonreparable nature of the error, on the human or technical origin of the error, or on responsibility or imputability of the error. In all cases, there is a strong similitude between the different classifications. In fact, each classification seems to evoke the same impression, only contrived for a different situation. Since there appears to be no common definitions, this creates tremendous problems when trying to collate results between different classifications. But the major criticism when analyzing aircraft accident data is the inability of these theories to evoke preventative measures. In fact there is no direct relationship between the type of error and the nature of the underlying cognitive failure. On the contrary, analysis seeking to establish relationships between the types of error illustrate that errors from the same behavioral category may happen under the effect of different causal mechanisms. In the same way, errors from different behavioral categories may share common etiologies (12). In consequence, preventative actions instituted as a result of these classifications are more symptomatic than etiologic.

The contextual level

Analysis conducted at the contextual level introduces causal assumptions about the observed erroneous behaviors. Nevertheless, general assumptions in most cases derived from the accident data favor some sort of erroneous behavior. The contextual level analysis introduces a dynamic component to describe error production mechanisms. The purpose of such an approach is to identify the conditions where one erroneous behavior happens at one specific moment in a behavioral sequence. Then, the facts of an accident that have no direct relationships with erroneous behavior may provide a clue as to the analysis of error mechanisms. One direct consequence of this analysis stage is the necessity to collect as much information about the error circumstances as possible. However, in this case, it may prove difficult to easily capture certain information in the database. Contextual classifications are numerous but often focus on a specific situation. In aviation, authors such as Chappelow (4) or Foggetter (7) have proposed a mixture of classifications, including behavioral, contextual and conceptual data. The difficulties with this approach reside in the apparent equivalence between different types of error and with the possibility of overlap between categories of behavior. Another limitation in the use of contextual classification is that contextual factors do not adequately explain why identical or similar circumstances do not always lead to the same types of error. This demonstrates that an accurate description of error mechanisms is more important to the understanding of human error than is the causal relationships between context elements.

Finally, preventative measures which result from causal analysis can be divided into 3 categories:

- teaching pilots how to identify "risk" situations,

- training the pilot to cope, manage, and avoid "risk" situations, and

- suppressing the contextual elements implied in the production of erroneous behavior.

The third preventative action constitutes a dilemma for pilots because they must distinguish between the reality of the constraints to achieve the task, safety, and performance. To suppress a plethora of contextual elements, one can create conditions where the task is not realizable and safety prevails over performance.

The conceptual level

The third level of aircraft accident analysis expands upon the assumptions implied in error production and management. For this, classifications are based on theoretical supposition rather then the elements connected with error production as behavioral and contextual levels. To achieve such an analysis, the part of the analyst is very important because he interprets observed data using human error theoretical models as a reference to study the error mechanisms. One shortfall associated with such a procedure is the interpretative characteristics of the conclusions made by the analyst. It is very difficult for the analyst to clearly interpret conceptual data because:

- Interpretations are subjective and as a result could result in different assumptions. Experience demonstrates that under certain circumstances the analysis of one situation may result in different results depending on the objectives. In fact, the more the information, the less the ambiguity.

- The direct implication of this limitation is that the experience and competency of the analyst are essential qualities to insure the validity of the interpretations when using theoretical models, but also to keep the connection between the different analysis of accidents consistent. From a practical standpoint, the capture of conceptual data in a database has to be achieved by a centralized level, even if the first analysis is conducted by the investigation board. However, human factors investigators on the investigation board have to be trained to conduct such a conceptual analysis because collecting field data cannot be simplified by a checklist or a series of boxes to fill in. The quality of the data collection, the ability to exploit the database, and the relationships between the initial data depend directly on the expertise of the human factors investigator. Synergy is necessary between the different intervening parties in the human factors "chain" to analyze and exploit accident data.

- The consequence of such a procedure is a better understanding of human error and resulting preventative measures. Human error is not only erroneous behavior, but is also an essential element in integrating human activity. Error is unavoidable when seeking high levels of cognitive and physical performance. By accepting such a limitation, it should help human factors engineers to better define the necessary tasks and, as a result, design a more suitable man-machine interface and training curriculum for pilots.

Conceptual classifications currently used are relatively recent and are still being improved by continuing fundamental human factors research. Classifications are derivatives of cognitive psychology, cognitive ergonomics, psychosociology and macro-ergonomics. In the coming years, new ideas may appear which would add a new dimension to aircraft accident investigation and analysis. For now, the most commonly used models are the following:

- The generic error-modeling system (GEMS) described by Reason (1990) is based on Rasmussen's work (13). It focuses on the level of control in cognitive activities. This model describes mechanisms of error production at an individual level. For each control level of activity (control based on skills, rules or knowledge), there is one specific type of error. Reason distinguishes 3 types of error: slips of execution, lapses of memory and planning faults. A final type of error not directly linked to information processing can be added but under a different category: violations.

- Woods et al. (19) analyzed human error like a symptom and not like a cause. Human error has to be the starting point of investigations to understand how error occurs. Authors propose a model to identify the error components. Human error results from individual and organizational mechanisms. At each of these two levels, actions or decision makings are the product of relationships between three factors: knowledge factors, attention management factors and strategic factors.

- Many psychosociological models are derived from numerous studies of aircrew in commercial aircraft. These studies (9,5,18,10,11) are the foundation of such concepts as Crew or Cockpit Resource Management (CRM) or Line Oriented Flight Training (LOFT). Among the studies of collective aspects of work are some ergonomics studies (17) which stress the importance of a common situational awareness by the working team.

- Detection and recovery models of human error focus primarily on the dynamic management of errors. Error is human, then in spite of all ergonomic, support and training actions to prevent errors, pilots will continue to make errors. However, human beings have learned to live with these errors and have developed cognitive strategies to limit the consequences of such errors. The main strategies are the detection and the recovery of errors. Such strategies are achieved mainly through experience. A safe pilot is a pilot who

produces few errors, but also one who knows how to detect and recover from the errors that do occur (2). This ability to detect and recover from errors can only add to the existing knowledge and help improve flight safety. For this reason, there is a growing need for "human factors" specialist to develop new knowledge on error detection and recovery.

- Safety models describe the production and management of errors through the different hierarchical or functional levels of a production system. One of the best known and more recent models is the embedded safety model of Reason (14). Showing the narrow and often hidden relationships between decisions made by managers and their consequences on activity of front line operators, this author points to a new attractive way to improve safety.

- New studies continue to appear in the literature (15), these studies generally describe the glass-cockpit technologies found throughout the world, placing an emphasis on the cultural differences in the pilot relationship with automation.

Of the 3 classically described levels of analysis (behavioral, contextual and conceptual), a fourth can be added: dynamic analysis of elementary events leading an incident. Much less studied than the other levels, the dynamic analysis of elementary events is, however, essential to the understanding of the genesis of accidents.

Dynamic analysis of elementary events

As classically described as the "error chain," each incident results from a dynamic imprecation of cognitive errors. Taking into account the temporal dimension between the different cognitive mechanisms is the key to a better understanding of accidents.
On many investigation boards, investigators use a 3-step model to describe this dimension: initial causes, main causes and aggravating causes. Such a model integrates the complexity of relationships between the different evoked mechanisms but does not consider their dynamic and temporal characteristics. This gap is important because there is a loss of information during the dissection of an accident.

The dynamic analysis does not have to integrate only the production mechanisms of errors, but also has to take into account the error detection and recovery mechanisms, as described in the previous chapter. Grau (8) who has conducted a study of French air force fighter aircraft accidents has shown that 50% of accidents happen when crews have detected an abnormal situation and tried to diagnose the error to recovery. Data on production, detection and recovery of errors are often well identified in the investigation report. Problems occur when the analyst tries to capture these data in a database, because now, there is an absence of a satisfactory model to describe the complex relationships between the cognitive mechanisms. Studies on human error have led to a description of elementary error mechanisms, but very few of the studies have focused on the relationship of the models dynamic characteristics. This lack of knowledge plays a significant roll in the design of relevant databases. In effect, one major criticism of human factors databases is their inability to predict errors (1). After an accident, the analysis of databases often leads to findings of previous occurrences with similar characteristics, but it is much more difficult to predict if an occurrence is precursory for future accidents. Reason (14) agrees with this point of view, databases should play a very specific role in the analysis and prevention of error: investigative reports enables the analyst to identify specific problems, information in a database allows the analyst to confirm these problems, while research allows the investigator to study and define the mechanisms and causalities.

To improve the predictive properties of databases, they require the incorporation of modelization for temporal and dynamic unveiling of cognitive mechanisms involved in aircraft accidents. By adding such a dynamic feature to databases, it could lead to a more preventative understanding of aircraft accidents and safety.

"Human Factors" Databases and Flight Safety

Flight safety and experience feedback

In flight safety, the database is strongly linked to accidents in general. Such a point of

view is restrictive in relation to the recent approaches in the field of human factors in aviation. Human error is not synonymous with aircraft accidents. For instance, during a low level navigation mission, a fighter pilot strikes a high tension wire; if, after contact, the aircraft is no longer controllable, he initiates an ejection and the aircraft crashes: the incident is identified as an accident. If the pilot can continue to control the aircraft and lands safely, the wire strike is classified as an incident. If the pilot simply grazes the wire, then the incident may or may not be reported, depending on the pilot. In this last case, two cases can be identified. First, the pilot is aware he has grazed the high tension line; consequently, he is aware of his error. Second, the pilot does not see the tension line and he is not aware of the danger. In all scenarios, the cognitive mechanism leading the pilot to strike or graze the high tension line is the same. On the contrary, the incidence classification is based on the consequences of the outcome.

If flight safety personnel only analyze accidents and serious incidents, the experiences gained by pilots will be lost, consequently this reporting method is not necessarily ideal in understanding or analyzing human error. To study human error means that all instances of error where detected and recovered must be recorded for analysis. If this principle appears to be obvious, it can also apply to other areas of human factors such as G-loss of consciousness (G-LOC). In effect, if one wants to study G-LOC in fighter aircraft, one cannot rely on studies where G-LOC is the main cause of accidents. It is necessary also to investigate all other situations where pilots lose consciousness and recover without further incident.

From a practical point of view, the study of accidents caused by human-factors is not sufficient to identify, describe, understand and modelize the human factors mechanisms involved. Much more rigorous approaches have to be identified: approaches where the spectrum of analysis includes minor incidents, anomalies, close encounters, indeed all daily activity. In the field of commercial aviation, this approach is called experience feedback. The "Aviation Safety Report System (ASRS)" database maintained by NASA is an example of an experience feedback database. Every civil or military pilot can declare and describe anonymously an incident that he thinks would be of interest to the aviation community at large. Unfortunately, in military aviation, much of this type of information is lost at the squadron bar and is never formally documented. The idea of designing an "experience feedback" database is attractive, but the ASRS experience demonstrates that such a system is not so easy to develop and some methodological recommendations or changes have to be made (3). On the hand, "experience feedback" databases can be appropriately exploited if the amount of information is sufficient for each incident. Nevertheless, anonymity and information confidentiality are two prerequisites to guarantee the databases success. These two elements of "experience feedback" lead to the following comments:

- Anonymity is not always compatible with sufficient (quality) information collection. In many air forces, the description of the aircraft, mission, occurrence location, pilot background and occurrence circumstances gives the readers enough information to determine who the anonymous pilot is. Unfortunately, these data are very important. Such is the problem with the ASRS database where essential information is not recorded to safeguard pilot anonymity.

- The person who (retrieves the) records the data is essential. Objective data from behavioral analysis are open to all, but the same is not true for contextual data, conceptual data and dynamic analysis. In addition, one can tend to have doubts about the objectivity and completeness of the data when the person involved in the incident is the one reporting and analyzing the data. Finally, those who make a declaration are not necessarily representative of the entire pilot population, which constitutes a bias for validation of data.

"Experience feedback" is an attractive way to improve flight safety. The difficulties lie in trying to design an effective databases on "human factors" experience feedback:

- The first step is to develop a methodology taking into account the limitations described above (anonymity, deliberate declaration and objectivity)

- Secondly, one must define the exploitation methodologies to guarantee an exhaustive and systematic analysis of the data. In effect, one of the weaknesses of databases is the under-exploitation by the analysts, either by lack of methodology or by lack of means.

Flight safety and pilot activity

Up to now, experience feedback and human factors databases have been designed by considering human behavior from a negative perspective. In aviation as other complex working environments, studies on pilot activity demonstrate the importance of human involvement to ensure safety. In general, when a production system is safe, very few people ask why. Ergonomics has emphasized in most cases the management of one's own cognitive resources in order to maintain a high level of performance in a complex system when situations are uncertain, poorly defined, with unadapted procedures and high temporal pressures and decisions have to be made. The capability to regulate the situation varies and is unpredictable. Events are often underestimated, even indeed unknown, by management because they are considered as normal. This is, in fact, an important information source to improve safety, but it has to be collected and exploited.

The positive role of the human in working environments is becoming a priority for agencies involved in safety. It is easy to see why such an approach could be of interest; on the other hand, it is another matter on how to proceed. The first barrier to strengthen is the weak evolution towards the positive role of the human. To accomplish this, different hierarchical levels of management require a better understanding of the limitations and capabilities of human operator. The second barrier is the quantity of data required to process. The last barrier is the absence of models which take into account the positive activities of the operator. The first barrier is a training problem, the second concerns methodology, and the last research.

In spite of these difficulties, some "experience feedback" developments do exist, expressing the more positive elements of the human operator. Among the most popular of these methods, it is possible to record systematic flight analysis from flight recorders in commercial aircraft. These analysis for the first time have been automated and included operator interviews. Currently, these analysis are more of a case analysis which means there is no need to capture data in a database. Here, too, systematic analysis is probably an attractive way to better understand the positive role of pilots in flight operations and flight safety.

Conclusions

The approach and analysis for the collection of "human factors" data in aircraft accidents are complex problems because:

- The data codification is reducing and distorting the process requiring constant demanding monitoring. Consequently, the choice of coding is very important.

- The coding choice is a compromise between neutrality and relevance.

The investigative fields in human factors are so numerous. To conduct an exhaustive human factors evaluation requires experts in many fields .

- Human factors data from accidents are only a small part of the "human factors" data required to better understand the role of the operator in the working environment.

- Effective exploitation of the databases does not exist, therefore, must be designed.

Human factors data collection is an essential part of flight safety. If at first this data collection appears easy, further analysis of the problems demonstrates that many variables are still not well known or understood and that much more research is required.

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CHAPTER III

INVESTIGATION, CATEGORIZATION, AND ANALYSIS OF NATO AIRCRAFT ACCIDENTS—CURRENT STATUS

Accident Investigation in NATO

Immediate response to an accident is universally the responsibility of the local flight surgeon. In some nations, an interim investigation board is formed to collect and preserve data. The basic composition of the accident investigation board is common among all the NATO countries surveyed and includes the following four members as a minimum:

- President
- Pilot/Investigation Officer (usually current in aircraft)
- Maintenance
- Medical

Although basic accident investigation procedures are common, the additional members of the board and other details vary. Other members are routinely added by some NATO countries: Psychologist (The Netherlands, United Kingdom, France, Germany), lawyer (Spain, Belgium), air traffic control (Italy), and ergonomics (France). For some nations, the same individual serves as both president and pilot/investigation officer. Several countries also provide routine administrative/support personnel (Netherlands, Portugal, Spain, Italy, United Kingdom) or additional consultants as needed. Although most NATO nations investigate accidents using military personnel, the USAF has recently been criticized for investigating accidents within the chain-of-command (13).

Accident investigation training for board members varies widely. United States Air Force flight surgeons receive 20 hours of academic training in accident investigation analysis and in accident prevention (5). In approximately half of the NATO countries, the entire accident board is selected ad hoc for each accident. In five countries, one or more of the board members are full-time safety/accident investigation personnel (permanent board members). In terms of investigation teams, some countries such as Portugal, the Netherlands, Spain, and the United Kingdom have full-time investigation teams. There has been recent controversy about USAF accident investigation procedures, criticizing the lack of full-time safety personnel on the accident board (5,13,8).

There is quite a lot of variation in professional background of board members responsible for the human factors portion of the investigation. While many countries utilize the flight surgeon to investigate human factors, several countries add the additional expertise of a psychologist (The Netherlands, France, Germany, The United Kingdom) or an ergonomist (France). In some NATO countries (Germany), the central aeromedical institute is responsible for the human factors portion of the investigation. In one country (Portugal), a specially trained pilot is responsible for human factors investigation.

There was considerable variation, not only between nations but between different military services of the same nation, in the time allotted to the investigating board to complete their investigation. This ranged from as short as 10 days to 5 months or even longer. The procedures for obtaining an autopsy also vary considerably. In approximately half of the nations, the autopsy is performed by military pathologists, and in the remaining half, civilian procedures are followed. Although several nations included a detailed neuropathological review as part of the autopsy, this varies widely. In most nations, the pathologist performing the autopsy does not have a special background in aerospace pathology. In some case, the pathologist is assisted by a flight surgeon. Military organizations in some NATO countries, such as the United States (Armed Forces Institute of Pathology), Germany, and The United Kingdom have special expertise in aerospace pathology:

The legal status of the investigation has an impact on both the data collected and on its releasability. For example, major portions of U.S. Air Force findings are not usable for legal

proceedings. This has the benefit of greater witness willingness to testify. Murphy noted reluctance by many organizations to share safety information largely based on fear of litigation, bad publicity, or punitive action F.A.A. violation policy (8).

Categorization, Analysis, and Tabulation of Aircraft Accidents in NATO

There are a variety of definitions as to what constitutes an aircraft accident or mishap (6). Each NATO country has a unique schema for defining aircraft accidents, incidents, etc., and for determining the level of damage which warrants an investigation. Generally, most countries base these schema on both severity of aircraft damage and injury to crewmembers (either severe aircraft damage or severe injury results in the accident being classified as major).

Criteria for aircraft damage severity vary between countries. In some cases, aircraft damage is quantified by cost to repair (U.S. categorizes an accident as a major or Class A if the cost to repair the aircraft is greater than $1,000,000). In other nations, the measure of aircraft damage used is repair hours (the Netherlands categorizes aircraft requiring more than 800 hours of maintenance work as accidents). In other cases, the requirement to send the aircraft for depot maintenance (Italy, United Kingdom, Canada) or a decision that the aircraft is not economically repairable (Belgium, France) is used as the criteria.

Criteria for aircrew member injury severity, likewise, vary between countries. Many countries use number of duty days lost due to injury as a measure (a major accident being defined as 30 lost duty days by the Netherlands and 28 days by the United Kingdom). In other nations, death or disability resulting from an accident is used as the criteria (the United States defines any mishap causing permanent total disability as major or Class A).

All NATO nations used flying hours as a measure of exposure and aircraft accident rates were expressed as accidents per flying hour. Most NATO countries define flying hours as the time from brake release; however, some nations (e.g., Italy) define flying hours as the time from engine start to engine shutdown. Most NATO nations express accident rates per 10,000 flying hours while some, including the United States, use a denominator of 100,00 flying hours. The use of flying hours as a measure of exposure has been criticized as not being scientifically sound because a disproportionate number of accidents occur on landing or take-off (6). This criticism applies to civilian accident rates where the cruise phase of flight is relatively hazard free. By contrast, in military aviation, the mission profiles vary widely, often including relatively hazardous actions, such as air combat maneuvers, low-level flight, weapons delivery, etc.

Various approaches to classification of accidents are possible (8,6,11). For example, the USAF Safety Center classifies accidents according to phase of flight.

- loss of aircraft control
- controlled flight into terrain - range
- controlled flight into terrain - non-range
- mid-air collision
- landing
- take-off

Classification according to the human factors involved is another approach. Canada, France, Germany, the Netherlands, Portugal, and the United States use specific protocols to investigate the role of human factors in causing aircraft accidents. The U.S. Air Force, U.S. Navy, and U.S. Army all have a unique human factors protocol.

Some of the nations which don't use a specific protocol do have a general categorization schema (Spain and France), but these again are unique to these nations. Norway, Belgium and Italy allow the investigating board to determine accident casualty without the second level guidance of a specific protocol or categorization schema.

Among the nations using specific protocols, both the general categories and the specific human factors elements vary widely. Categories and definitions used to analyze aircraft accidents are not static. For example, the U.S. Air Force accident investigation form (711GA) underwent a major revision in 1989 and in 1996. For

several countries, including the USAF, categorization codes are not mutually exclusive or dichotomous variables. Extensive lists of possible categories are not formulated so that members can be aggregated into larger categories.

Chapter II explained that a necessary approach to accident prevention is to address incidents/close calls. In the U.S., several incident databases are used by the FAA (4). The best large incident database in the United States is the Aviation Safety reporting system (ASRS) (2). Reporting is voluntary but this database, managed by NASA and Battelle, guarantees anonymity to aircrew. Major limitations of this database were that reporting was voluntary and details of the report were not independently verified or investigated (8). Six out of the NATO nations surveyed also used anonymous incident reporting systems. Reporting of air incidents is inconsistent, with some countries (ex. Canada, Germany) reporting over 2,000 incidents per year while other countries (ex. Portugal and Belgium) report 10-20 incidents per year.

Common Database/Pooling Accident Data - General Issues

In addition to the limited number of aircraft accidents, differences in definitions and classification schemes have also been obstacles to rigorous epidemiologic study. While combining data from several nations may increase statistical power, problems due to miscategorization and confounding may be compounded. In this circumstance, increased statistical power may be coincident with decreased validity.

Although NATO nations use different definitions of aircraft accidents, it appears that most accidents classified as a major accident under one country's set of definitions would also be classified as such under another country's definitions. For all NATO countries, an aircraft destroyed or an aircrew fatally injured would be labeled a major accident. The majority of major accidents fall in this category. However, for accidents involving neither an aircraft destroyed nor a fatality classification differences might exist..

The problem of accident causality is much more complex. As described in Chapter II, the choice of coding system defines the capabilities of the database. Most coding systems do not correspond to a theoretical human factors framework. Such a framework would facilitate human factors analysis and identification of interventions (14). In most cases, NATO countries do not use internationally accepted categorization schemes. Even where such schemes exist and are well accepted by epidemiologists, a new and incompatible code is often invented. For example, the USAF uses its own unique code for injury rather than existing codes such as International Classification of Diseases (ICD).

The use of specific terminology may differ between countries (12). Understanding of phenomena such as spatial disorientation and its definition have evolved over time with a consequent change in how accidents are categorized (7,1). Categorization can also vary from service to service within the same country (7). The 34 databases described by Murphy and Levendoski (8), all use differing terminology, definitions, and guidelines for data collection. The authors recommend both standardized terminology and guidelines for data collection (8). As noted by Navathe, differences in definition can result in markedly different reported rates for different types of accidents (12).

Even after questions of definition and categorization have been addressed, underlying differences in aircraft accidents from country to country may threaten the validity of the findings. Differences in rates from one NATO country to another may represent underlying differences in the flying experience. Likewise, categorization of accidents as being due to human factors varies between nations, with widely varying proportions of accidents being attributed to human factors. Can these samples from each NATO country be considered to come from the same underlying population for purposes of pooling the data? Is it reasonable to combine them? Are measures of risk relatively constant from sample (country) to sample (country)? If the odds ratios are sufficiently different, then this may be in itself a significant finding. Even where underlying rates are comparable, the possibility of differences in the

occurrence of various cofounders in the populations being pooled is not ruled out.

In addition to the technical and epidemiologic considerations discussed above, concerns about confidentiality or how the data might be used may limit free exchange of data. Exchange of commercial databases is limited by concern that it could be used by competitors to their advantage or by federal agencies in enforcement actions (9). Confidentiality of witness testimony is another factor limiting free exchange of data. For example, in the USAF, all confidential witness testimony, contractor-consultant reports, recommendations, and other deliberations are protected from disclosure, except for purposes of accident prevention (3). This protection, however, has been recently challenged.

Data retrieval techniques are in a rapid phase of development. Experts predict that ability to search text will develop rapidly in the near future. Excessive investment in coding systems may be fruitless.

Analysis of Existing NATO Accident Data

Overall accident rates for several NATO countries and for selected branches of service (Air Force, Navy, and Army) are shown in Annex A, Question 2. These accident rates are also stratified by aircraft type (fighter, other fixed wing, and helicopter). Overall national accident rates vary by aircraft type with fighter aircraft generally showing the highest rates. Accident rates do not demonstrate a significant trend over the years from 1990 to 1995. Rates also vary from service-to-service, even for similar aircraft types within the same nation. For example, both the U.S., French, and Royal Navy have higher rates for fighter accidents than the corresponding U.S., French and Royal Air Forces. For helicopter accidents, the French and the U.S. Army has lower rates than the corresponding navies and air forces. Overall accident rates appear lowest in German Forces, the French Army, and the USAF. Overall rates for the Italian Forces appear elevated, but rates stratified by aircraft type are not all elevated; for example, IAF helicopter accident rates are the lowest in NATO. An increased proportion of fighter aircraft flying can skew overall rates and make them appear elevated. Rates for the Canadian Forces and for various naval forces are elevated, both when stratified by aircraft type and overall, perhaps reflecting a different flying experience.

Conclusion

Combining heterogeneous data from various countries may increase statistical power.

- Differences in definition, in categorization schema, and in the rates of various cofounders in the populations being pooled may adversely impact the validity of resulting conclusions.

- A stratified analysis by country should be performed before combining the data to detect that factors which differ from country to country.

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CHAPTER IV

METHODOLOGICAL STRUCTURE OF A HUMAN FACTORS DATA BASE. RATIONALE

1. Introduction.

This chapter provides a general description of human factors under the perspective of two models already accepted by the human factors specialist community. Although many models have been described, in accordance with a number of flight safety organizations it has been thought the two models selected here provide a good starting point for a better understanding of the proposals for human factors data collection described in Chapter V.

2. Existing models.

2.1. SHELL Model.

This model was first described by Edwards in 1972 and later modified by Hawkins (Hawkins 1972) and provides a systematic approach to identifying problems coming from the interaction of the human with his environment. As depicted in Figure 1, each component of the model (software, hardware, environment, interindividual liveware and intraindividual liveware), represents one of the building blocks of human factors studies. The human element is not just a passive subject, but also an active agent and the centerpiece of the model, representing the most critical and flexible component (pilot and crew, Figure 1).

The relationships among these five components, represented by their initial letters (SHELL) illustrate the model. Each component interface with other components, but is the human element which interacts with all of the components (Wiener 1988).

2.2. Reason model.

Reason (1990) has distinguished between two modeling approaches, one based on the individual error production and cognitive mechanism or Generic Error Model System (GEMS) and a model of Accident Causation, based on an organizational or System Error Production, where latent failures (decision makers, line management and preconditions) or active failures (productive activities and defenses) can be distinguished (Rameckers 1992).

The model of Accident Causation, described by Reason in 1990, is a theoretical framework to consider the etiology of accidents in a complex technological system involving large industrial processes, such as energy and chemical production, or the mass transportation by road, rail, sea or air (Reason 1990).

This comes from the assumption that all man made systems contain potentially destructive agencies, such as the pathogens within the human body, and that human error is not confined to front-line operators, but is a feature of all humans at all hierarchical levels in any complex organization.

Reason identified the basic elements common to all such productive systems and then represented them as building blocks identifying the essential components of effective production. Into this framework, human error prevails at all levels and accidents are caused by a network of factors, generated not only by unsafe acts of front line operators, but also by fallible management decisions and all kinds of preconditions that exist in the operation environment.

3. Rationale.

It has been thought reasonable to combine these two models within the framework of the SHELL model and an explanation has been offered of the basic elements or items related to those human factors which might be studied under the course of an aircraft accident investigation. But the SHELL model by itself sometimes does not provide appropriate information regarding the accident as a consolidated fact as it is mostly descriptive at the behavioral level and does not provide adequate information regarding the conceptual level.

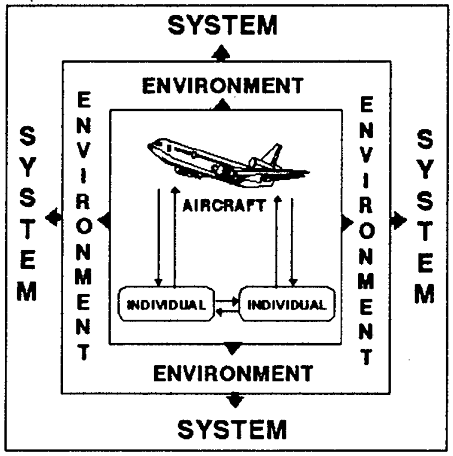

Figure 1

Reason's model (1990) includes the following:

(a) A wider perspective of some of the elements (mechanisms) that led to the accident by describing the cognitive mechanism of individual error production and the Generic Error-Modeling System (GEMS), which gives an integrated picture of the error mechanisms underlying action slips, lapses and mistakes (skill, rule and knowledge based error) is provided.

(b) A causality model in a complex productive system (decision makers, line management, preconditions and defenses). Figure 2 represents the Reason causality model in a complex system and its interface with the SHELL model.

To establish a model or prototype protocol for the systematic collection of significant and useful data for flight safety purposes is difficult (ICAO 240-AN/144, Wiener 1980). The large number of protocols and procedures defined in this field clearly show there to be a lack of a valid approach from a practical and analytical point of view.

This publication has attempted to provide a platform where the individual and his/her environment are described as items. These items are then divided according to the SHELL model to provide a valid and easy to understand concept, but integrated in the dynamic cognitive-organizational model defined by Reason to improve analysis. In other words, the systemic embedded safety model (Reason) and factorial data (SHELL) are related to show the various contributing factors to the breakdown of a complex system-accident scenario. In addition, a block of factors which might be quantified as predisposing or causal factors in the sequence of events which led to the accident is examined. These elements need to be considered in the context of the case of one individual (aircrew), who is a contributor to the production of the events leading to the accident.

Whereas the Reason model allows for the understanding of the mechanism of accident causation, the SHELL model introduces the necessary information to feed the Reason model and generate a production mechanism of the error (see Figure 2). In this way, a global and real overview of the facts which finally led to the accident or incident is obtained. This information enables the investigator to construct the chronological course of events and acquire knowledge of those factors which may have influenced the accident-producing behavior. This information encompasses the decisions and actions which may be needed for analysis and further recommendations.

3.1. DEFINITION OF SHELL MODEL FACTORS

I. Factors relating to the individual (LIVEWARE- Intraindividual).

I. 1. Physical factors.

Capabilities and limitations of the individual. Motor and sensory skills plus anthropometric attributes.

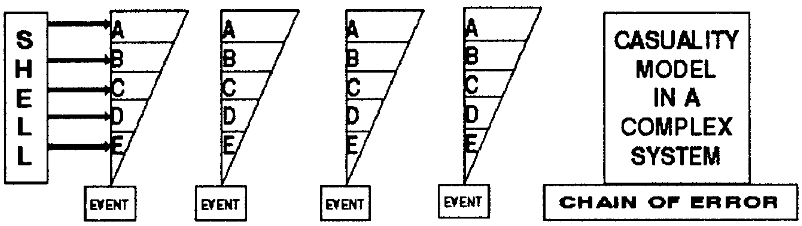

Figure 2

I.2. Physiological.

Large array of human systems as a complex organism. Includes nutrition, stress, fatigue and lifestyle considerations.

I.3. Pathophysiological.

Deal with health status of the individual and pathological problems that might interfere with him.

I.4. Psychological factors:

Includes all settings brought by the individual to work situations as knowledge, experience, perceptions, information processing, attention span, workload, personality, mental and emotional state, attitudes and mood.

- I.4a. Cognitive
- I.4b. Personality
  - a. Emotional state
  - b. Behavior
  - c. Personality traits

I.5. Psychosocial

Deal with pressures brought to bear on an individual by the social system.

II. Factors related to the individual and their work.

II.1. Liveware-liveware (interindividual).

The liveware-liveware interface is the relationship between the individual and any other person in the workplace. Human interactions and communication.

II.1a. Worker-fly
- Verbal communication (oral & written)
- Nonverbal communication (visual)
- Crew interactions
- Controllers
- Passengers

II.1b. Worker-management
- Personnel
- Supervision
- Pressures

II.2. Liveware-Hardware

It represents the relationship between the human and the machine. Hardware is the first of the components which requires matching with the characteristics of man. It concerns tasks such as cockpit and workstation configuration, display

and control design and seat design configuration.

II.3. Liveware-Software

This encompasses the non-physical aspects of the system. Reflects the relationship between the individual and supporting systems such symbology, regulations, manuals, checklist, publications, standard operating procedures and computer software design.

II.4. Liveware-Environment

It is the relationship between the individual and the immediate work area, plus the external environment as outskirts physical environment, political, social and economical constraints under which the aviation system operates. Data requirements include weather, terrain, physical facilities, infrastructure an economic situation.

II.4a. Internal

II.4b. External

3.2. Definitions of Reason's model, latent and active failures:

a. Decision makers.

These include high level managers and architects of the system. They set goals of the system and also direct the means by which these goals should be achieved. Their function concern with the allocation of finite resources, as money, equipment, people and time, deploying these resources to maximize productivity and safety.

b. Line management.

These are departmental specialist implementing decision makers' strategies. Their particular sphere of operation varies into: training, personnel, operation, engineering support, safety etc..

c. Precondition.

These are a set of qualities possessed by both people and machines, for instance: work schedules, maintenance programs, environmental condition, codes of practice, equipment, attitude, motivation, skill and knowledge of the workforce.

d. Productive activities.

These are humans and mechanical activities on the front line to deliver in time the product in the right way.

e. Defenses.

These are safeguards enough to prevent foreseeable damage or costly issues.

3.3. SHELL and Reason model interface.

The following items constitutes the elements of the SHELL model corresponding to frames of the Reason model, described as:

A: Decision Maker
B: Line management
C: Preconditions
D: Productive activities
E: Defenses

Figure 3, describes Reason model structure according to frames A-E.

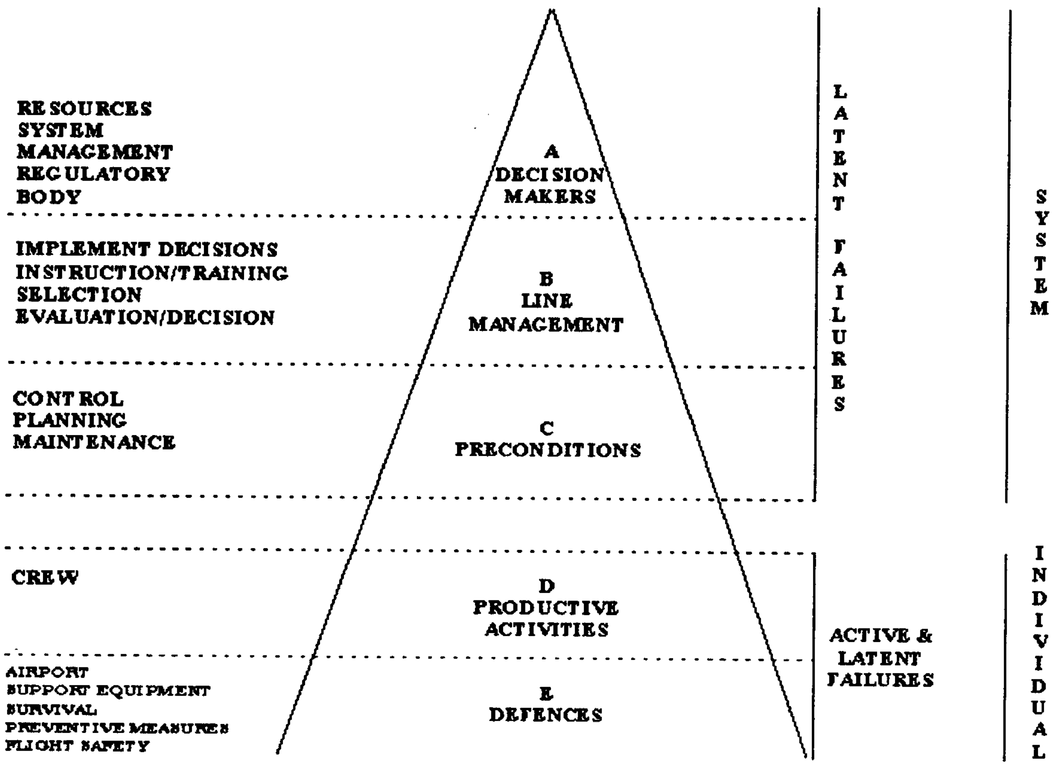
RESOURCES
SYSTEM
MANAGEMENT
REGULATORY
BODY
IMPLEMENT DECISIONS
INSTRUCTION/TRAINING
SELECTION
EVALUATION/DECISION
CONTROL
PLANNING
MAINTENANCE
CREW
AIRPORT
SUPPORT EQUIPMENT
SURVIVAL
PREVENTIVE MEASURES
FLIGHT SAFETY
A
DECISION
MAKERS
B
LINE
MANAGEMENT
C
PRECONDITIONS
D
PRODUCTIVE
ACTIVITIES
E
DEFENCES
LATENT FAILURES
ACTIVE & LATENT FAILURES
SYSTEM
INDIVIDUAL

Figure 3

3.3.I. Factors relating to the flyer (LIVEWARE).

1. Physical factors .... D
1a. Physical characteristics .... D
1b. Sensory and perceptual limitations D
- Vision
- Vestibular
- Situational
- Auditory
- Propioceptive

2. Physiological .... D C
2.1. Nutritional
2.2. Fatigue
2.3. Jet lag

3. Pathophysiological .... D
3.1. Health status/pre-existing disease
3.2. Sleep deprivation
3.3. Drugs/alcohol
3.4. Stimulants
3.5. Sudden incapacitation
- CO poisoning
- Hypoxia
- Hyperventilation
- G-LOC
- Motion sickness
- Food poisoning
- Acute illness
- Toxic fumes
- Other

3.6. Decompression
3.7. Radiation
3.8. Thermal stress
3.9. Dehydration
3.10. Illicit drugs
3.11. Illusions

4. Psychological factors:
4a. Cognitive.

Factors enclosed in this area can be defined as follow:

1. Situational awareness:

A pilot continuous perception and understanding of self and aircraft in relation to the dynamic environment of flight, threats and mission and the ability to forecast, then execute the task.

2. Attention:

Act of keeping one's mind closely on something.
Improper attention: failure to pay attention to one or more activities or operations.

3. Memory ability:

Process of recalling to mind facts or experiences.

4. Knowledge:

Fact, act or state of knowing a range of information, awareness or understanding.

5. Experience:

The act of living through an event or events, including training and personal participation.

6. Planning:

Process or method for making doing or arranging something.
Failure to plan: to choose appropriate flight options for known conditions and contingencies or to properly modify flight plan in response to unanticipated conditions and contingencies, and develop these into a course of action to maximize probability of mission accomplishment.

7. Workload:

Quantity of attention necessary to achieve the task.

8. Judgment:

The mental process used in the formulation of a decision.

9. Mental fatigue:

Subject mental performance impairment, as a consequence of the exposure to an specific task.

1. Situational awareness.. D
- Perception (Non/Mis/Delayed)
- Reaction time
- Disorientation
- Other

2. Attention .... D
- Distraction
- Chanalized attention
- Cognitive task

oversaturation
- Temporal distortion
- Other

3. Memory ability .... D
   - Lapses
   - Total
   - Other

4. Knowledge .... D B
   - Techniques/Skill
   - Procedural
   - Other

5. Experience .... D C A
   - In position
   - In aircraft type
   - On route /aerodrome/night
   - Emergency
   - Other

6. Planning .... D C
   - Pre-flight
   - Inflight
   - Other

7. Workload .... D C
   - Physical task oversaturation
   - Prioritization
   - Other

8. Judgment and decision making .... D
   - Ignored caution, warning
   - Judgment
   - Delay in taking necessary action
   - Rush
   - Select wrong course action
   - Risk assessment

   - Intentional failure to use accepted procedure
   - Violation flight discipline
   - Other

9. Mental fatigue .... C D
   - Acute
   - Chronic
   - Sleep deprivation
   - Other

4b. Personality

a. Emotional state .... D
   - Anger
   - Anxiety
   - Apprehension
   - Carefree
   - Depression
   - Elation
   - Irritability
   - Panic
   - Pressure/Stress
   - Other

b. Behavior .... D
   - Boredom
   - Complacency
   - Careerism
   - Motivation inadequate
   - Motivation displaced
   - Overaggressive
   - Over-commitment
   - Overconfidence
   - Preoccupation
   - Pressing
   - Other

c. Personality style .... D
   - Anti-authoritative
   - Impulsive
   - Invulnerable
   - Macho
   - Resigned
   - Submissive
   - Authoritative
   - Insecure
   - Explosive
   - Narcissistic
   - Other

5. Psychosocial .... D C A
   - Peer pressure
   - Family or friend death/illness
   - Recent separation/divorce
   - Recent engagement/marriage
   - Family or marital problems
   - Interpersonal relationship
   - Financial problems
   - Legal problems
   - Recent holiday/vacation
   - Recent or planed change in career/job

- Significant lifestyle changes
- Culture
- Family pressure
- Other

3.3.II. Factors related to the individual and their work.

II.1. Liveware-Liveware (HUMAN-HUMAN INTERFACE)

II.1a. Crew-fly

* Oral communication .... D C B E A
  - Disrupted communication
  - Noise interference
  - Misinterpreted
  - Phraseology
  - Radio discipline
  - Other

* Visual communication D C B E A
  - Non verbal communication
  - Ground/hand signals
  - Other

* Crew interactions .... D C B E A
  - Supervision
  - Briefings
  - Intracockpit coordination
  - Compatibility/pairing
  - Other

* Controllers .... D C B E A
  - Supervision
  - Briefings
  - Coordination
  - Others

* Passengers .... D C B A E
  - Behavior
  - Briefing
  - Knowledge of aircraft/procedures
  - Other

II.1b. Crew-management

* Personnel .... A B E
  - Recruitment/selection
  - Training
  - Policies
  - Crew pairing
  - Operational support/control
  - Instructions /directions/orders
  - Other

* Supervision .... A B E
  - Operational supervision
  - Quality control
  - Standards
  - Other

* Pressures .... A B
  - Mental
  - Morale
  - Peer
  - Other

II.2. Liveware-Hardware (HUMAN-MACHINE INTERFACE) .... A B C D

II.2a. Equipment

II.2b. Workspace

II.3. Liveware-Software (HUMAN-SYSTEM INTERFACE) .... A B C D

II.3a. Written information

II.3b. Computers

II.3c. Regulatory requirements

II.4. Liveware-Environment (HUMAN-ENVIRON. INTERF.) .... A B C D

II.4a. Internal .... D
  - Heat, cold, humidity
  - Ambient pressure
  - Illumination, glare
  - Acceleration
  - Noise interference
  - Vibration
  - Air quality

II.4b. External
- Weather .... D
- Terrain .... D
- Infrastructure.... .A D E
- Dispatch facilities
- Aerodrome
- Maintenance
- Airport survival and rescue facilities .... E

CONCLUSION

The identification of a valid model to configure a human factors data base for further retrieval and analysis is a difficult task. A basic framework to be used as a tool for the prevision of a report by a human factors specialist has been developed.

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CHAPTER V

AN OVERVIEW OF THE APPROACH TO HUMAN FACTORS DATA COLLECTION

Introduction

Aircraft accident investigation boards determine the cause of each aircraft accident in order to prevent a similar occurrence. The findings of the investigation could be classified under three main headings: engineering, environment and human factors. In recent years, human factors have been reported to be the main factor in the causation of aircraft accidents. Annex A, Question 3, estimates are found from various NATO services of the human factors contribution to aircraft accidents.

With the increasing sophistication and reliability of aircraft and aircraft systems, the human being has become the limiting factor, as aircraft performance may now exceed human physiological and psychological tolerances.

The collection of information for analysis of human factors involved in aircraft accidents has proved difficult for a number of reasons of which the following are representative:

a. Some accident investigation boards may not have access to the expertise of human factors specialists.

b. The terms and expressions used to record human factors evidence have not been defined and standardized, resulting in misunderstandings and incompatibility of data.

c. Boards of inquiry may not have access to specialist expertise to elucidate the interaction between the physiological, cognitive and psychosocial findings.

Human Factors Data Collection

Aircraft accidents and incidents are classified in various ways in different countries as described in Chapter III. However, an aircraft incident could be seen to be an accident avoided (e.g., a near miss versus a mid-air collision), and the information concerning the human factors contribution to an incident can provide important information identifying trends in accident causation. To facilitate early recognition of adverse trends in human factors analysis, access is required to a larger number of accident and incident reports where the human factors material has been expressed in internationally defined terms.

In an era which is seeing reductions in the military strengths of virtually all nations, and a corresponding reduction in military aviation, the acquisition of information from the larger numbers of civilian accidents and incidents is vital. Although civil and military flying tasks differ in their mode of operation, military and civil aviation technology and aircraft systems are often similar and, with respect to human factors, the lessons learned can be very often applied to both types of operation.

This paper is an attempt to provide an overview of possible human factors areas which could provide a basis for further international data exchange and which may be incorporated, at least in part, in the existing accident investigation protocols of different countries.

Broadly speaking, human factor analysis could be divided into three main areas:

a. Those factors which are solely concerned with the human being and are independent of aircraft type. Into this area fall such things as fatigue, personality, social and economic problems. In other words, those physical and psychological parameters which would have an effect on the performance of the aircrew whatever the aircraft type or whatever the mission.

b. Those aspects of the flight which are related to limitations put upon the aircrew by the design and structure of the airframe, cockpit ergonomics or aircrew personal and survival equipment.

c. Matters relating to organization, selection, training, and leadership.

These areas are dynamically interactive, complicating the prediction of outcome from any one factor. In the first attention is focused on aircrew selection, personality, physical characteristics, psychological stresses and information processing, whereas in the second case, attention is drawn to the need to provide airframes, cockpits and equipment designed around human capabilities to allow aircrew to best perform the task required.

There is an urgency to increase the access to the human factors information being collected by various agencies as we are now moving into a new era in aircraft operations. Whereas in the past the pilot has been the operator of the aircraft, this role is changing with the introduction of ever increasingly sophisticated computerized flight and navigation systems as well as an increasingly complex operational environment. In some cases, pilots are no longer flying aircraft, but can be mainly monitoring systems and displays. Aircraft have come into service in which the familiar Instrument panel has been replaced by computerized cockpit, head up and helmet mounted displays, with the flying controls familiar in flying training having been superseded by sidestick controllers and computer keyboards. It is well known that human beings are poor monitors of systems, that attention is limited when directed to the supervision of machines, that the response time to an emergency signaled by the monitored systems is slow and that the time taken for the person to gain an awareness of the emergency and actively take control of the system is considerable. In some circumstances, the transition from passive monitoring to active intervention may not be achieved at all. The significance of the move to computer controlled flight in terms of accident avoidance and damage mitigation is at present unknown and the concerted effort of both civil and military aviation authorities is necessary to ensure all information concerning in-flight incidents and accidents is distributed widely so that trends may be detected at the earliest opportunity.

At first glance some of the data suggested for collection below may not appear relevant to human factors, but flying computer controlled aircraft presents two significant risks:

a. In an emergency situation, the pilot must change from a passive, computer-monitoring role to an active flying task with quite different perceptual requirements. This introduces the problem that the pilot feels himself to be no longer a part of a man/machine interface but to be monitoring aircraft performance from the "outside." Hence, automatization needs to be intelligent, with respect to maintaining the pilot active in the man/machine system and in the mission loop.

b. Modern computers are able to present too much information to the pilot, i.e., he has to monitor up to six screens, look at the instruments and helmet-mounted displays while maintaining a good look-out. In this particular situation, the pilot may be at the limit of his mental performance (attention, perception, memory, judgment, and capacity for action), so that any minor irregularity of the aircraft may lead to an inappropriate response.

Any proposal for data collection must allow for the full expression of the initiative of the investigator on the accident site. The goal is to delineate the more important areas for data collection and to distinguish those areas which lend themselves to statistical evaluation from those which are best recorded in narrative form. The working group has assembled a list of the core areas of information required from each accident for basic research into the human factors associated with aircraft accidents. It must be stressed that the list below is intentionally not exhaustive, requiring the accident investigator to include information and findings unique to each accident.

Most aircraft accidents and incidents are investigated immediately at the site (first level) and the evidence is documented and standardized, reports produced and conclusions drawn later (second level). This can result in some of the first level evidence being lost, especially contributing factors which may have appeared not to have had an influence on the causation of the accident or incident. To avoid this loss of information, the human factors elements can be recorded on a 5-7 part scale ranging from "no effect" through "possible

effect" to "definitely a factor." This will allow trends in the causes of accidents or incidents to be reviewed at a later date with a revised approach based on new findings. In addition, the relevance of new psychological approaches to the collection of data related to the man-machine systems interface, organizational relationships, selection, training, communication and the investigation of aircraft incidents should be stressed, as proactive intervention is important in the prevention of further aircraft occurrences.

PRINCIPAL AREAS FOR AIRCRAFT DATA COLLECTION

The human factor implications of an aircraft accident should always be reviewed alongside the detailed collection and analysis of engineering, medical, pathological and procedural data. The following, while in no means exhaustive, outlines the major areas for data collection and, although not assigning priorities in any one category, gives examples of some of the human factors topics in each area.

Personal
Age, sex, qualifications, experience and flying time on accident aircraft type, mission experience, performance level and assessment of flying skills.

Physiological
Sensory or perceptual limitations, boredom, fatigue and circadian rhythms, history of air sickness, acceleration tolerance, altitude related factors, somatic-sensory illusions.

Psychological
This item encompasses personal habits, personality types, motivation and mood. Areas of special interest for further description are personality development, professional difficulties, professional dissatisfaction, crew position, past experiences including previous accident/mishap history, stress, motivation for flying, ambition, attitudes to authority, crew members and risk-taking, emotional stability, phobic reactions, personality profile, cognitive processing limitations, decision making, judgment, situational awareness/disorientation and reaction to emergency.

Psychosocial
Crew composition, leadership and communication, can be items related to either psychological or psychosocial areas.

Other common problems are, marital situation, family and interpersonal relationships, financial problems and non-aviation related activities.

Organizational
Operational organization, selection and training, mission demands, flight procedures, support from other aircrew, management.

Engineering
Cockpit ergonomics, instrumentation and displays.

Environmental
Weather related factors, temperature related, noise, vibration, radiation and environmental hazards, speed related factors, geographical.

Post accident survival
Human factors aspects of problems with injury, escape sequence, ejection, ground egress survival training, rescue.

Conclusions

With ever changing mission requirements resulting in constant alterations in the requirements of the aircrewman to respond to new environments, both within and without the aircraft, any approach to human factors data collection must remain flexible and responsive to new trends in accident causation .

In order to recognize the type of human factor responsible for the accident at a very early stage we need a very thorough understanding of the basic interactions and data from a large number of aircraft accidents and incidents

It has become apparent that more effort will be required to fully understand the complexity of modern aviation operations and missions, particularly in man-machine, man-system and interpersonal aspects.

The list containing proposed areas of data is the first step towards international standardization of aircraft accidents and incident investigation designed to obtain a larger number of cases and hence to recognize trends at a very early stage so that corrective actions can be implemented early. Given that the above proposals are agreed by the various nations, further work is required to detail all the relevant human factors groups and subgroups for the collection of data and to provide a definitive list of terms and definitions to avoid misunderstandings and ensure a standardized multinational approach.

Chapter V, Appendix 1

FRENCH AIR FORCE APPROACH TO A HUMAN FACTORS DATA BASE (BASEAC: Base de Données des Évènements Aériens du CERMA)

Introduction

Presence of human factors causes in more than 70% of aircraft accidents is a fact. In order to identify, analyze, and investigate the events which lead to an aircraft accident, The French Aerospace Medicine Institute (Institut de Medicin Aeroespatiale du Service de Santé des Armée, IMASSA) has created a specific human factors Data Base called BASEAC: Base de Donnees des Evenements Aeriens du CERMA.

Objectives

The main goal is the analysis of quantitative and qualitative human factor data collected from the investigation reports. Results from the analysis would be the establishment of correlation's, percentages, factorial analysis and many other figures critical for a comprehensive approach to determine the proper preventive measures directly oriented to avoid new events.

A second objective is to learn from a global point of view which human factors have been involved in accidents. The term human factor is very encompassing, therefore, three subcategories has been established:

- human factors as primary factors of aircraft occurrences
- injuries and fatal data
- escape and survival data

A third objective is to facilitate human factors data comparison between occurrences occurring in different missions and aircraft, but also with other work situations where there is complex process controls (nuclear,...).

BASEAC allows us to:

1. find out flight safety aspects of interest
2. make recommendations to prevent similar events
3. define areas of special concern for research or study
4. validate potential model of human behavior concerning human error.

BASEAC Principles

BASEAC focuses on human error mechanisms. The analysis model of aircraft occurrences has two axes: the analysis level of occurrences and the level of human errors.

The human error may be considered at three levels:

- individual error done by the front line operator (pilot, weapon system officer,...)
- collective error done by an aircrew or by a team working in the same goal
- organizational error concerning unsafe decisions taken in the hierarchical levels.

The analysis level of occurrences is between descriptive and explicative data. Descriptive data are objective facts. Factors are objective but their implication in the occurrence genesis is more interpretative. Explicative data or error mechanisms are interpretations done by analyst. In this sense, explicative data are dependent of analyst subjectivity.

BASEAC Description

BASEAC is a relational database, including 11 files. It is very easy to jump from one file to another, page by page, following the proper organizing menu. For one's files, one card alone is filled (for instance, flight occurrence or factors). For other files, several cards may be filled if there are, for instance, several aircraft or aircrew members implied in the occurrence.

FILE 1. Flight Occurrence.

This file includes the following items :

1. Occurrence number
2. Year
3. Case finished
4. Number of aircraft involved

5. Type of occurrence:
   - Aircraft accident
   - Aircraft accident (no specify)
   - Major Incident
   - Minor incident

6. Summary of facts

7. Causal
   - Personnel
   - Materiel
   - Environment
   - Combination
   - Non-determined

8. Initial cause

9. Main cause

10. Collateral cause

11. In flight sudden incapacitation

12. Remarks item number 11

13. Human factors involved (according to IMASSA model)

14. Place of human factor in the information processing path
    - Operator error
    - Fail in the system followed by operator wrong answer
    - No operator error

15. Bail out

16. Survival facts

17. Meteo

18. Ground characteristics

19. Geographical facts
    - Snow
    - Desert
    - River
    - Seaside or lake
    - Forest
    - Populated area
    - Countryside
    - Airfield

FILE 2. Morbidness

This file includes the following items :

1. Occurrence number
2. Number of aircrew
   - Killed
   - Major injuries
   - Minor injuries
   - No lesions

3. Military personnel (no aircrew)
   - Killed
   - Major injuries
   - Minor injuries
   - No lesions

4. Civilian personnel on board
   - Killed
   - Major injuries
   - Minor injuries
   - No lesions

5. Ground personnel
   - Personnel directly involved
   - Personnel no directly involved

6. Summary of morbidness

FILE 3. Flight Context

This file includes the following items:

1. Occurrence number

2. Aircraft identification number

3. Aircraft category

4. Type of aircraft

5. Unit

6. Type of mission

7. Flight in formation
   - Rejoin after take off
   - Flight over
   - Rejoin exercise
   - Patrol mission
   - Combat air/air
   - No specific objective

8. Flight phase

9. Occurrence during training

10. IFR/VFR

11. Aircraft status
    - Solo
    - Patrol
    - Disposition of X aircraft
    - Leader
    - Team number 1
    - Team number 2
    - Team number 3

FILE 4. Personnel on Board

This file includes the following items :

1. Aircraft identification number

2. Identification of aircrew member

3. Specialty
    - Pilot
    - Navigator
    - Weapon System Officer (WSO)
    - Mechanical engineer
    - Boom Operator
    - Passenger (military)
    - Passenger (Civilian)

4. Function on board
    - Pilot solo
    - Pilot forward seat
    - Pilot back seat
    - Commander of aircraft (multiplace)
    - Instructor pilot
    - Undergraduate Pilot Trainee (UPT)
    - Graduate Pilot Trainee (GPT)
    - Copilot
    - Navigator (Instructor)
    - GPT (cargo)
    - GPT (helicopter)
    - Undergraduate Navigator (UNT)/WSO Trainee
    - Other

5. Qualification
    (Level of Qualification on Mission Ready, Flight-Lead Qualified, etc.)

6. Flying time on the aircraft subject to occurrence
    - Total
    - Total flying time in aircraft subject to occurrence
    - Total 6 previous months
    - 6 months in aircraft subject
    - Total last month
    - 1 month in aircraft subject

7. Experience in aircraft subject to accident

8. Experience in other aircrafts

9. Military status
    - Only aircrew (pilot and navigator/WSO)

10. Problems related to crew training

11. Remarks on item 10

12. Problem related to professional career

13. Remarks on item 12

14. Previous crew member's accident
    - Aircraft
    - Automobile/motorbike
    - Remarks

15. Bail out

16. Pathological consequences
    - Killed
    - Major injuries
    - Minor injuries
    - No lesions

17. Description of injuries

18. Professional disability

19. Days of disability

20. Professional consequences

21. Remarks on item 20

22. Blood Glucose
    - Done

- Normal
- Abnormal (Dosage)

23. Alcohol
    - Done
    - Normal
    - Abnormal (Dosage)

24. Carbon Monoxide (CO)
    - Done
    - Normal
    - Abnormal (Dosage)
    - Smoking

25. Other toxicological findings
    - Done
    - Normal
    - Drugs/Medication
    - Drugs
    - Other

26. Histopàthological findings
    - Done
    - Results

27. Biological findings

FILE 5. Bail out

This file includes the following items :

1. Identification of aircrew member

2. Late bail out

3. Bail out conditions
   - Altitude
   - Speed
   - Mach
   - Other parameters of aircraft

4. Parachute bail out

5. Remarks to item 6
   - Remarks
   - Parachute training
   - Remarks to parachute training

6. Ejection

7. Ejection conditions
   - Type ejection seat
   - Ejection seat
   - Ejection seat sequence start
   - Use of sequence
   - Person who start ejection sequence
   - Ejection preparation
   - Training in ejection seat
   - Remarks in training

8. Consequences of ejection over personnel equipment

9. Pathological consequences of ejection
   - Grade of lesions
   - Description of lesions

10. General comments about ejection

11. Training in survival

12. Remarks item 11

FILE 6. Ground personnel

This file includes the following items :

1. Occurrence number

2. Identification of ground personnel

3. In flight or ground occurrence

4. Occurrence context

5. Specialty

6. Qualification

7. Professional career

8. Remarks item 7

9. Pathological consequences
   - Killed
   - Major injuries
   - Minor injuries
   - No lesions

10. Description of injuries

11. Professional disability

12. Days of disability

13. Professional consequences

14. Remarks on item 20

15. Blood Glucose
 - Done
 - Normal
 - Abnormal (Dosage)

16. Alcohol
 - Done
 - Normal
 - Abnormal (Dosage)

17. Carbon Monoxide (CO)
 - Done
 - Normal
 - Abnormal (Dosage)
 - Smoking

18. Other toxicological findings
 - Done
 - Normal
 - Drugs/Medication
 - Drugs
 - Other

19. Histopathological findings
 - Done
 - Results

20. Biological findings

FILE 7. Human error mechanisms

This file includes the following items :

1. Occurrence number

2. Slip and Execution

3. Personnel having produced slip of execution

4. Remarks on item 2

5. Faults

6. Type of fault
 - Mental resource management
 - Aircraft situation awareness
 - Environment situation awareness
 - Aircraft failure diagnostic
 - Environment degradation diagnostic
 - Erroneous intent
 - Choice of erroneous procedure

7. Remarks on item 6

8. Violation

9. Type of violation
 - Routine violation
 - Exceptional violation

10. Remarks on item 9

11. Collective error

12. Type of collective error
 - Common situation awareness
 - Collective resource management

13. Specific topic

14. Type of specific topic
 - Lack of knowledge
 - Transfer of knowledge
 - Mission preparation
 - Procedure conflicts
 - Deviation
 - Top-down reasoning
 - Learned level of knowledge

15. Organizational error

16. Type of organizational error
 - Maintenance
 - Training
 - Material design
 - Ergonomics
 - Regulation
 - Unadapted procedure
 - Work organization

18. Remarks on item 17

FILE 8. Factors

This file includes the following items :

1. Occurrence number

2. Medical and physical factors

3. Type of medical or physical factors
   - Personal identification
   - Remarks

4. Flight physiological factors

5. Type of flight physiological factors
   - G-stress
   - Hypoxia
   - Decreased atmospheric pressure
   - Decompression
   - Vibration
   - Remarks

6. Environmental factors

7. Type of environmental factors
   - Hot
   - Cold
   - Visual parameters (color, 3D vision, moving, ...)
   - Visual support systems
   - Personal identification
   - Remarks

8. Psychological factors
   - Fatigue
   - Aeronautical motivation
   - Wish to do well
   - No-aeronautical preoccupation
   - Familial concern
   - Professional concern
   - Personal identification
   - Remarks

9. Communication factors
   - Media quality
   - Professional language
   - Leadership
   - Expertise
   - Personal identification

10. Organizational factors
    - Remarks

FILE 9. Error detection and recovery

This file includes the following items :

1. Occurrence number

2. Situation degradation identification

3. Human error identification

4. Human error diagnosis

5. Error recovery attempt

6. Error recovery attempt result

FILE 10. Analysis

The purpose of this file is to summarize the main human factors characteristics of the occurrence. Data allow to accurate the dynamical aspects of the occurrence genesis.

FILE 11. Investigation

The purpose of this file is to identify the failure of investigation board on human factors to make recommendations and improve human factors investigations.

This file includes the following items:

1. Occurrence number

2. Occurrence facts

3. Mission facts

4. Daily activity

5. Flight hours

6. Selection

7. Basic training

8. Operational training

9. Behavior

10. Mission preparation

Chapter V, Appendix 2

ITALIAN AF DATA BASE COLLECTION

The Italian Air Force (IAF) Regulations concerning aircraft accidents are applicable to all Italian Armed Forces and State Air Services with few exceptions. The IAF is responsible for the administrative closure of the accident documentation. The IAF gathers all data concerning such accidents on paper documents and in a database, including 50 items. Human Factor investigation is collected only on paper records. It consists of two parts: the first one is a questionnaire (Relazione Medica); the second one is a report written in accordance with the issues included in "Compiti dell'Ufficiale Medico."

RELAZIONE MEDICA
La compilazione della presente relazione viene effettuata dal Medico di Stormo/Dirigente il Servizio Sanitario dell'Aeroporto che raccoglie la documentazione sommaria avvalendosi della collaborazione sia di quello del Reparto che ha in forza organica il personale interessato sia del membro C.S.A. della Commissione d'inchiesta.

Quadro A - Informazioni riguardanti l'incidentato

Grado Cognome nome

data di nascita [ ] Luogo di nascita ______

Qualifica a bordo[1] [ ] Posizione a bordo[2] [ ]

Reparto di appartenenza ______

data di assunzione in forza al Reparto [ ]

I.M.L. dove è stata eseguita l'ultima VCOA ______ data [ ]

Esito ______

Data ultima VCOS [ ] Esito ______

Riassunto dei registri sanitari ed altre notizie sanitarie di rilievo degli ultimi 30 giorni

Stato civile

celibe [ ] separato [ ] coniugato con moglie non convivente [ ]

divorziato [ ] vedovo [ ] coniugato con moglie convivente [ ]

Data del matrimonio [ ] Matrimoni precedenti n. [ ]

Figli (elencarli per età e sesso, indicare se conviventi)

Luogo di residenza ______

Residenza abituale (se diversa) ______

Tipo di sistemazione

appartamento privato [ ] appartamento di servizio [ ] alloggio in caserma [ ]

Tempo mediamente impiegato per raggiungere l'aeroporto min. [ ]

Altezza m. [ ] Peso Kg [ ] Altezza in posizione seduta cm. [ ]

---

[1] Usare le seguenti abbreviazioni: Pilota Capo Equipaggio **P**; Secondo Pilota **2P**; Tecnico di volo **TEV**; Navigatore **NAV**; Direttore di Carico e Lancio **DCL**; altri Equipaggi Fissi di Volo **EFV**; Assistente di Volo **AV**; Osservatore **O** Passeggero **P**; altro **A**, (specificare sul retropagina).

[2] Usare le le seguenti abbreviazioni: non conosciuta **SC**; Pilota Capo Equipaggio **P**; Secondo Pilota **2P**; Tecnico di volo **TEV**; Navigatore **NAV**; Cuccetta **C**; Cabina Passeggeri **P**; altro **A**, (specificare sul retropagina).

Lunghezza natica ginocchio cm. [ ] Larghezza spalle cm. [ ]

Circonferenza toracica cm. [ ] Circonferenza vita (all'ombelico) cm. [ ]

Pratica sport ? Si [ ] No [ ]

livello: agonistico [ ] non agonistico [ ]

frequenza: più volte alla settimana [ ] più volte al mese [ ] occasionale [ ]

Fumatore ? Si [ ] No [ ]

Cosa ? sigarette [ ] sigari [ ] pipa [ ]

Quanto abitualmente ? [ ] al dì

Consumo di alcool (tipo alcolico, media giornaliera) ____________________

____

nelle 12 e 24 ore precedenti l'incidente ____________________

Assumeva farmaci ? Si [ ] No [ ]

quali e a che dosaggio ____________________

per quale motivo? ____________________

quali nelle 24 ore precedenti l'incidente? ____________________

per quale motivo? ____________________

prescritte dal M. di S. o dirigente [ ] dal medico curante [ ] autoprescritte [ ]

Ore trascorse dall'ultimo pasto [ ]

Tipo e quantità dei cibi ingeriti nelle ultime 12 ore ____________________

____

Tipo e quantità delle bevande consumate nelle ultime 12 ore ____________________

____

Ore di sonno dormite abitualmente [ ]

Eventuali variazioni nel ritmo circadiano negli ultimi 7 giorni

____

____

Periodi di sonno nelle 48 ore precedenti l'incidente
(dalle.......alle)

____

____

____

Periodi di lavoro svolti nelle 48 ore precedenti il decollo (dalle.......alle)

____

____

____

Breve cronistoria delle ultime 48 ore

____

____

____

Incarico primario ______________________________
Incarichi secondari ______________________________

Abilitazioni strumentali e qualifiche operative

____
____
____

Training medici teorici e pratici (es.: centrifuga, helo-dunker, camera ipobarica) (data, luogo, tipo di corso)

____
____
____

Precedenti incidenti di volo: (numero) [ ]

	Località	data e ora	tipo	fattore
1)				
2)				
3)				

	Lesioni riportate	Esiti

Precedenti incidenti stradali:

	Data	Tipo d'incidente	causa
1)			
2)			
3)			

	Lesioni riportate in tali incidenti	Esiti

Malattie importanti nei familiari (in caso di decesso indicarne la causa):

1) padre ______________________________
2) madre ______________________________
3) fratelli ______________________________
4) figli ______________________________

Eventuali ulteriori notizie sulle condizioni psico-fisiche dell' incidentato prima del volo e sue abitudini di vita:

____
____
____
____
____
____

FIRMA DEL MEMBRO MEDICO DELLA COMMISSIONE

____

Quadro B: In caso di sopravvivenza all'incidente
(Al seguente quadro dovrà essere allegata la scheda "Esame esterno")

Grado	Cognome nome	Mansione[1]	Posizione[2]

Lesioni riportate e modalità di produzione

Esami strumentali eseguiti ed il loro esito

Referto ospedaliero (in caso di ricovero):

1^ Visita di Controllo Straordinario dell'I.M.L. di ____________ effettuata il [ ]
Giudizio Medico Legale: ____________________________

Durata eventuale periodo di convalescenza gg. [ ]

Visite di Controllo Straordinario successive

Data	I.M.L.	Giudizio Medico Legale

FIRMA DEL MEMBRO MEDICO DELLA COMMISSIONE

____

[1] Usare le seguenti abbreviazioni: Pilota Capo Equipaggio **P**; Secondo Pilota **2P**; Tecnico di volo **TEV**; Navigatore **NAV**; Direttore di Carico e Lancio **DCL**; altri Equipaggi Fissi di Volo **EFV**; Assistente di Volo **AV**; Osservatore **O** Passeggero **P**; altro **A**, (specificare sul retropagina).

[2] Usare le le seguenti abbreviazioni: non conosciuta **SC**; Pilota Capo Equipaggio **P**; Secondo Pilota **2P**; Tecnico di volo **TEV**; Navigatore **NAV**; Cuccetta **C**; Cabina Passeggeri **P**; altro **A**, (specificare sul retropagina).

Quadro C: In caso di morte
(Al seguente quadro dovrà essere allegata la scheda "Esame esterno")

Grado	Cognome nome	Mansione[1]	Posizione[2]

Data dell'incidente [ ] ora [ ] Data della morte [ ] ora [ ]
Data dell'autopsia [ ] ora [ ]

Località e struttura dove è stata eseguita l'autopsia [ ]
Cognome e nome del medico che ha effettuato l'autopsia

Grado cognome e nome dell'Ufficiale medico che ha assistito all'autopsia

Stato di conservazione e fenomeni post-mortali del corpo al momento dell'autopsia

Caratteri distintivi esterni e mezzi d'identificazione

Lesioni esterne, scheletriche e degli organi interni

Modalità di produzione delle lesioni

Malattie preesistenti

[1] Usare le seguenti abbreviazioni: Pilota Capo Equipaggio **P**; Secondo Pilota **2P**; Tecnico di volo **TEV**; Navigatore **NAV**; Direttore di Carico e Lancio **DCL**; altri Equipaggi Fissi di Volo **EFV**; Assistente di Volo **AV**; Osservatore **O** Passeggero **P**; altro **A**, (specificare sul retropagina).

[2] Usare le le seguenti abbreviazioni: non conosciuta **SC**; Pilota Capo Equipaggio **P**; Secondo Pilota **2P**; Tecnico di volo **TEV**; Navigatore **NAV**; Cuccetta **C**; Cabina Passeggeri **P**; altro **A**, (specificare sul retropagina).

Risultato di esami tossicologici

Esame radiografico

Causa della morte (Specificare l'infermità o la condizione che ha portato direttamente alla morte, cause antecedenti e condizioni di morbilità ed ogni altra condizione che ha contribuito a causare la morte)

Eventuali conclusioni del medico che ha effettuato l'autopsia

FIRMA DEL MEMBRO MEDICO DELLA COMMISSIONE ________________________________

Quadro D - Comportamento dell'equipaggiamento individuale
(Da compilarsi per ciascun componente dell'equipaggio)

Registrare i capi di equipaggiamento indossati e la loro efficacia barrando la casella interessata; in caso negativo descrivere il perché della inefficienza sul retro pagina assieme ad altre annotazioni che si ritengono rilevanti.

Grado	Cognome nome	Mansione[3]	Posizione[4]	Grado lesioni[5]

Le informazioni devono riguardare i seguenti capi:

	non-previsto	non-indossato	indossato efficace	non-efficace	non-rilevabile
Casco	☐	☐	☐	☐	☐
Complesso visiera	☐	☐	☐	☐	☐
Equipaggiamento per l'ossigeno (maschera, complesso tubo personale, ecc.)	☐	☐	☐	☐	☐
Microfono/altoparlante /laringofono	☐	☐	☐	☐	☐
Occhiali di volo correttivi	☐	☐	☐	☐	☐
Sottocombinazione da volo	☐	☐	☐	☐	☐
Indumento isolante termico	☐	☐	☐	☐	☐
Indumento per il condizionamento termico (ad aria, a liquido o elettrico)	☐	☐	☐	☐	☐

[3]Usare le seguenti abbreviazioni: Pilota Capo Equipaggio **P**; Secondo Pilota **2P**; Tecnico di volo **TEV**; Navigatore **NAV**; Direttore di Carico e Lancio **DCL**; altri Equipaggi Fissi di Volo **EFV**; Assistente di Volo **AV**; Osservatore **O** Passeggero **P**; altro **A**, (specificare sul retropagina).

[4]Usare le seguenti abbreviazioni: non conosciuta **SC**; Pilota Capo Equipaggio **P**; Secondo Pilota **2P**; Tecnico di volo **TEV**; Navigatore **NAV**; Cuccetta **C**; Cabina Passeggeri **P**; altro **A**, (specificare sul retropagina).

[5]Usare le seguenti abbreviazioni: Incolume **INC**; Ferito **FER**; Deceduto **DEC**.

	non-previsto	non-indossato	indossato efficace	non-efficace	non-rilevabile
Indumento anti-G (pantaloni, tuta)	☐	☐	☐	☐	☐
Calzini e guanti	☐	☐	☐	☐	☐
Tuta (di volo, da immersione, tuta da combattimento)	☐	☐	☐	☐	☐
Scarponi da volo	☐	☐	☐	☐	☐
Salvagente /giubbetto di sopravvivenza	☐	☐	☐	☐	☐
Vestiario protettivo NBC e respiratore	☐	☐	☐	☐	☐
Giubbetto antiproiettile/antischegge	☐	☐	☐	☐	☐
Arma personale	☐	☐	☐	☐	☐
Paracadute di emergenza	☐	☐	☐	☐	☐
Altro (specificare) ____________________	☐	☐	☐	☐	☐
Altro (specificare) ____________________	☐	☐	☐	☐	☐

FIRMA DEL MEMBRO MEDICO DELLA COMMISSIONE

____

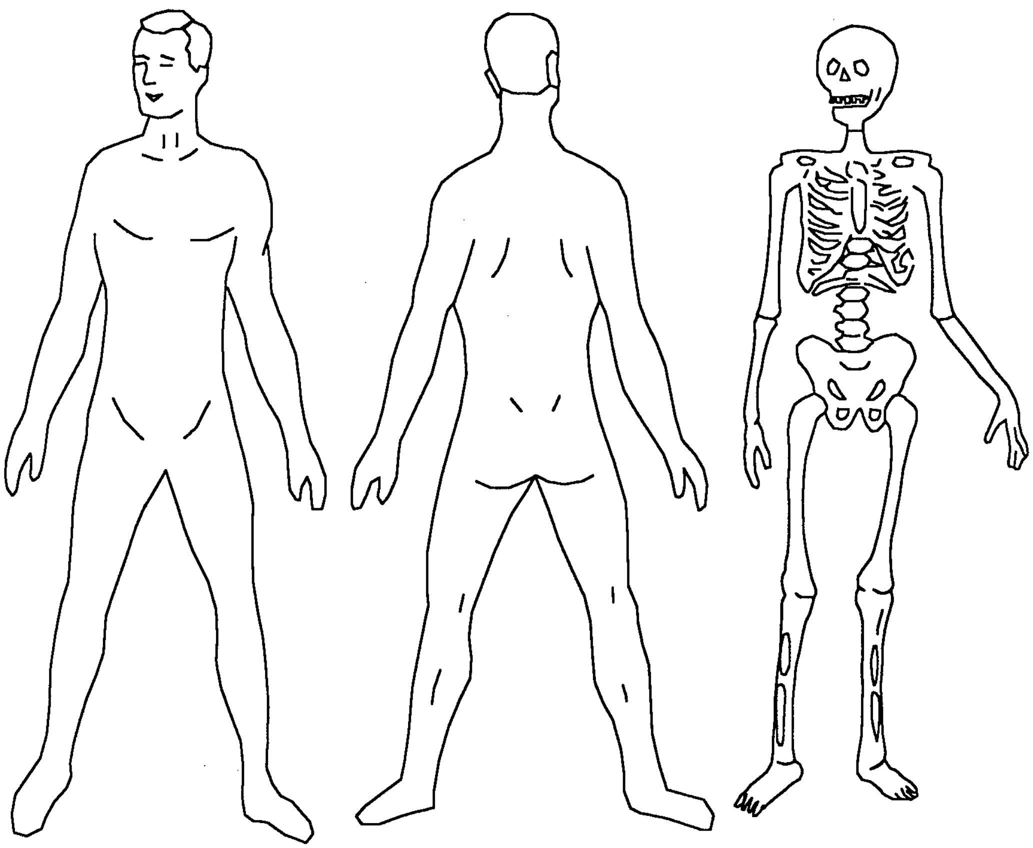
Esame Esterno

Grado Cognome Nome

Luogo e data di nascita

Data del decesso

Località del decesso



Legenda

1. Ecchimosi
2. Escoriazioni
3. Ferita
4. Lussazione
5. Frattura
6. Squarcio
7. Mutilazione
8. Ustione 1° gr.
9. Ustione 2° gr.
10. Ustione 3° gr.
11. Carbonizzazione

Annotazioni

COMPITI DELL'UFFICIALE MEDICO

L'Ufficiale medico è responsabile della raccolta dei seguenti elementi informandone la Commissione d'inchiesta Tecncio-formale:

1. la possibilità significativa di:

   a. Condizioni fisiche e mentali del pilota risultanti dall'esame della sua storia medica.

   b. Effetti sulle capacità del pilota di specifici fattori ambientali connessi con i compiti assegnati, l'ambiente di lavoro e l'ambiente familiare.

   c. Assorbimento di agenti tossici da parte del pilota.

   d. Ipossia ed iperventilazione.

   e. Perdita di coscienza derivata da patologie connesse.

   f. Ferite e loro gravità.

2. La possibile riduzione dei danni riportati attribuibili a :

   a. Inadeguata protezione nel cockpit.

   b. Difetti nella profettazione o nell'uso dell'equipaggiamento di volo e di salvataggio.

   c. Assenza di particolari specifiche negli equipaggiamenti personali di volo e di salvataggio.

3. Se tutti gli occupanti indossavano l'equipaggiamento di sicurezza appropriato (quando possibile) e se erano correttamente fissati al momento dell'impianto.

4. Inoltre, in caso di incidente fatale, si dovrebbero riportare :

a. Informazioni rilevanti derivate dalla posizione, dall'atteggiamento e dallo stato fisico del corpo.

b. Informazioni rilevanti derivate dagli esami sul cadavere, con particolare riguardo alla causa ed al momento del decesso ed allo stato di salute precedente. Una copia del referto autoptico è allegato agli atti della relazione sommaria.

c. Identificazione del corpo.

5. Ogni rilievo concernente l'efficienza o il miglioramento del servizio di pronto soccorso.

Chapter V, Appendix 3

The following is a portion of a booklet that is given to United States Air Force flight surgeons to help them conduct an investigation of a Class A flight mishap. The computer program referred to in the following text is a self-contained windows program, likely meaning no other software is necessary to run the application.

Life Science Program

This program produces a report that replaces the AF 711gA mishap investigation form. The concept behind the collection of life sciences data has changed. Basically, rather than trying to collect many discrete data points in a linear fashion, a logic tree approach along with the collection of a few key data points is used. Depending on your answers to questions in the logic tree, you may be directed, at different points, to provide detailed information in the narrative portion of Tab Y, Part I (Note: Tab Y is the flight surgeon's section of the mishap investigation report).

The goal is to have a Tab Y, Part I narrative that fully and only describes the relevant human factor, life support, egress, survival, and rescue aspects of the mishap; and to have a database of key discrete data along with "mishap pointers". "Mishap pointers" are actually your answers to questions in the logic tree. Some of those answers may required analyses by you or by an expert that you consult.

The program runs in a windows environment. This allows you to access your windows word processing program almost at any point while filling out the database information. The advantage of this is that you can make notes in a word processing file right after being prompted by an on-screen note to "provide an explanation in Part I of the narrative." Also, the notes that appear on-screen as a result of your answers to specific questions are maintained in the program and can be printed out later to remind you of items to include in the narrative.

Part I of the narrative should include an explanation of every "note" but is not limited to a discussion of only the notes. Part I of the narrative will include a discussion of all human factors or medical conditions investigated and found to be a factor in the mishap. Also, include any life support equipment problems or issues that were a contributory factor to the mishap sequence; and any human factor, medical, life support, egress, survival, or rescue problems that followed or were a result of the mishap sequence.

Part II of the narrative should include a discussion of factors investigated and found not to be a factor in the mishap. Also, include any life support equipment problems or issues that were not a factor in the mishap sequence (design through rescue) but were discovered during the investigative process and need to be resolved by the responsible agency to prevent problems or mishaps in the future.

Installation Process for Stand Alone Operation (not on LAN):

Put disk 1, Life Science Program, in drive A. Open your windows "File Manager," and click on the A drive icon. A list of files for drive A should appear; double click on the file "install.exe." This should start the installation process. Respond "Yes" to the choices

given during installation. Then put disk 1, IDAPI, in drive A and repeat the above process loading disk 2 of IDAPI when prompted. After the installation is complete you must close all windows and reboot. This will reset your "Path" in the "autoexec.bat" file. When you restart your computer, you will see the icon for the "Life Science Report" application group. The icon called "Life Science Program" starts the program that replaces the 711gA.

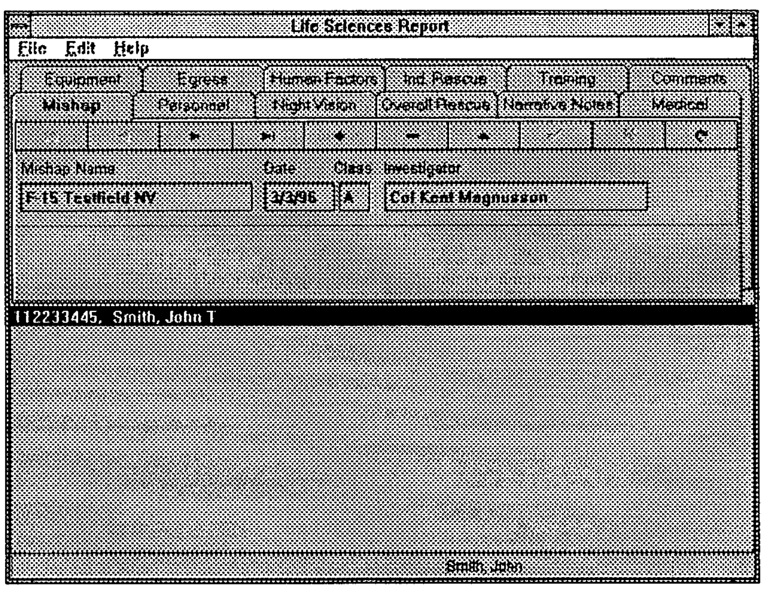
Saving and Downloading Data:

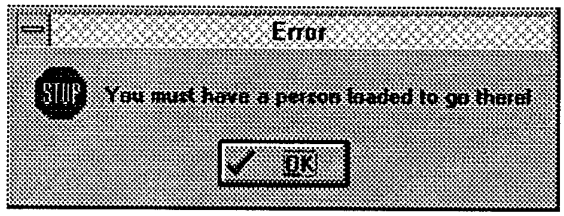
After entering a significant amount of data into to the Life Science program, i.e. an amount of data you would not like to reenter if the system crashed, you should use the File/Export function of the program to "save' the data. The export function saves the data to a 3½ 🖫 disk. When you are done entering data into the program at the end of the investigation then export the data onto two 3½ 🖫 disks, send one to AFSC/SEFL and keep the other disk until you have confirmation that AFSC/SEFL has received your disk.

Also send a second disk containing the files titled Part1.doc, Part2.doc, LSS.doc and HF.doc. These files are parts of Tab Y, described later in the section titled "Summary of Tab Y documents". DO NOT put these files on the same disk with the data downloaded from the Life Science Program.

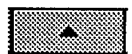
Program Notes

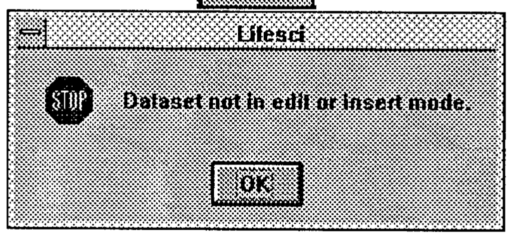
This is the main screen for the Life Sciences Report, each file tab will contain "fill in the blank," "choose from list", or logic tree questions (or combinations of these).





<u>You must start by entering basic information about the mishap</u>. The "Mishap Name" is a free form field, meaning you can enter anything you want. It is an identification field to separate mishaps; that is, if there were more than one mishap being processed or retained on the computer on which you are working. At a Class A mishap the only reason for you to have another mishap in the database is to create a dummy one with which to practice; a good idea for getting familiar with the program. <u>The other tabs will not become active until you enter a person's name in the "personnel" tab.</u>



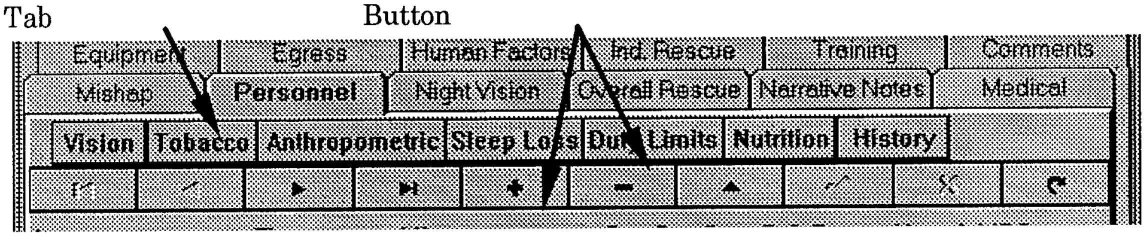


If you do have more than one mishap in the program or you are switching between mishaps or personnel in a mishap you may get a warning message about not being in the edit mode. If you get that warning just click on the "OK" button then click on the "edit record" button with the pyramid symbol as shown here.

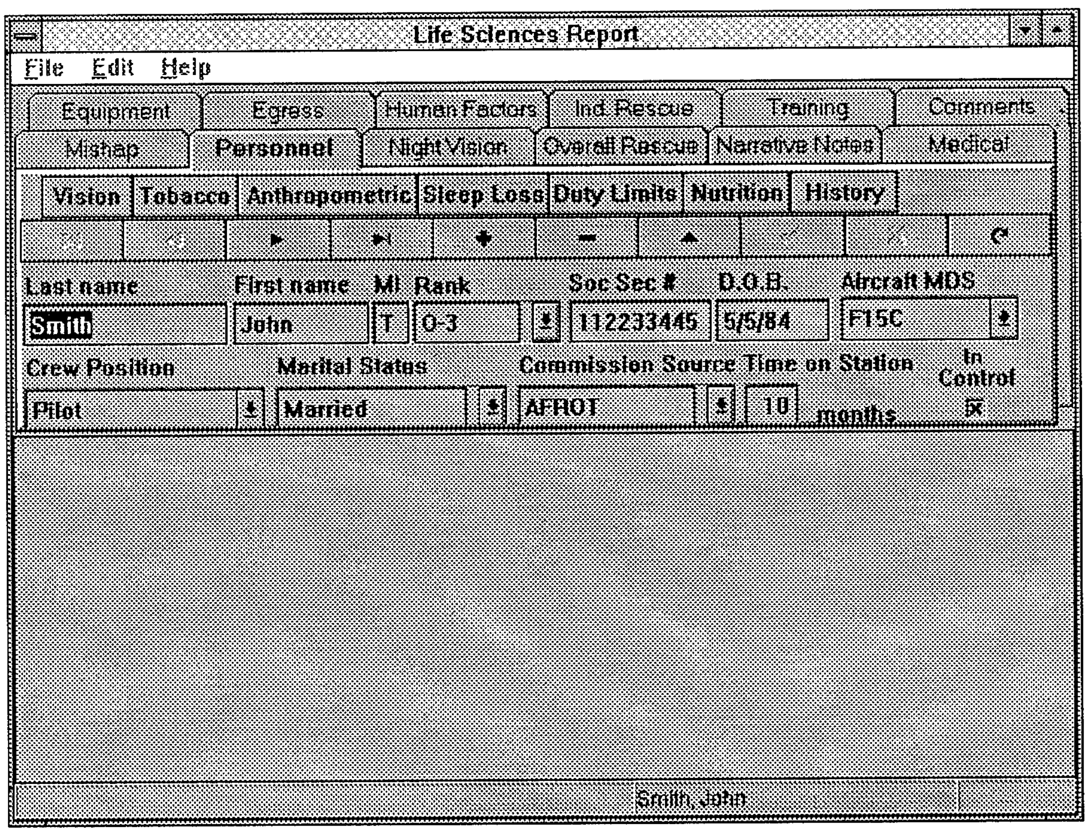
Clicking on the "Personnel" tab will open the personnel screen as shown in the graphic on the following page. When the screen appears you will notice a series of buttons at the top of the screen, these buttons are labeled to reflect the question areas or data requested at each button. The "Vision" button will start a series of questions asking about the vision of the individual whose name appears in the status bar on the bottom of the screen.

Tabs are the file folder headings and buttons are the rectangular looking "buttons" with either words or symbols on them.

Tab Button

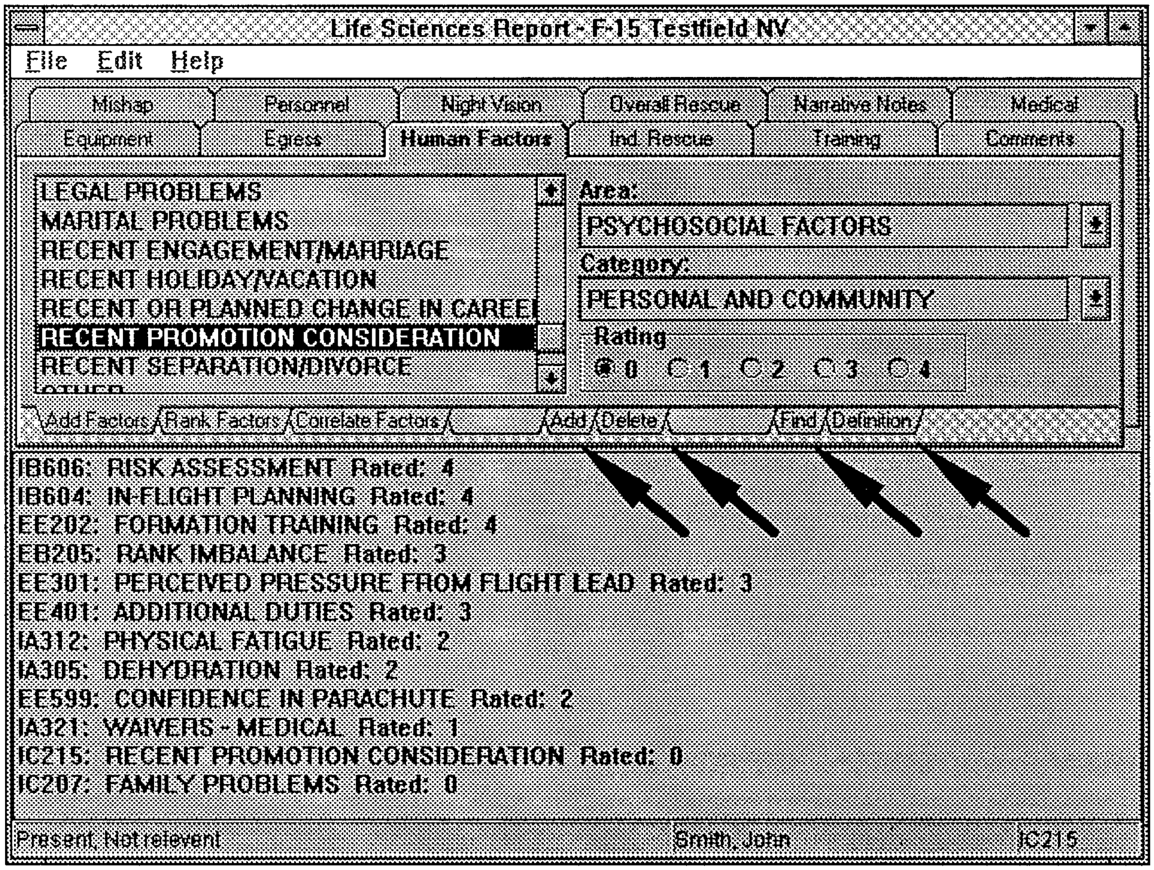


The logic tree questions and most of the "fill in the blank" data requests are started with the push of a "button". Left clicking on a button will show you what data has already been entered in that area. So left clicking the mouse on a button for the first time, for an individual, will return nothing or a series of data at a default setting, since nothing has been entered. Right clicking on a button will open a small window box that has four choices: View, Change, Add or Cancel. "View" does the same thing as left clicking, "Change" starts a data enter sequence either for the first time to initially enter data, or restarts data entry for as many times as you want to change the data in that area. The "Add" choice is usually subdued, meaning it is not active, however when active can be used to add data to an exiting list of data. "Cancel" returns you to previous activity.

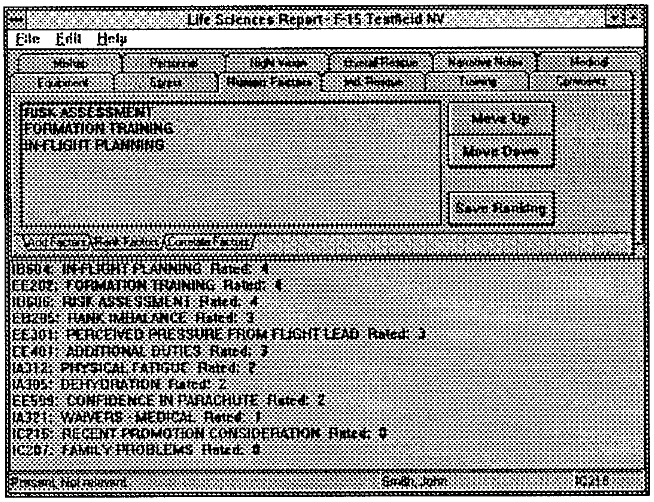


The Human Factors screen has many features. The area at the top reflects the human factor terms and definitions that are listed in this instruction and in AFI 91-204. After an "Area" and a "Category" have been selected then the corresponding terms are listed in the top left box with a scroll bar if necessary. After locating a human factor you can highlight it and then click on the tab titled "Definition" to see the description of when to mark the term as a factor in the mishap. If you have filled out the human factors worksheet first (worksheets included in this instruction), as is recommended, then you should not look through the "Area" and "Category" first but should click on the "Find" tab then enter the factor code number, the two letter three number code associated with each term. No matter which way you find the term you should next apply a rating, 0 to 4, and then click on the "Add" tab.

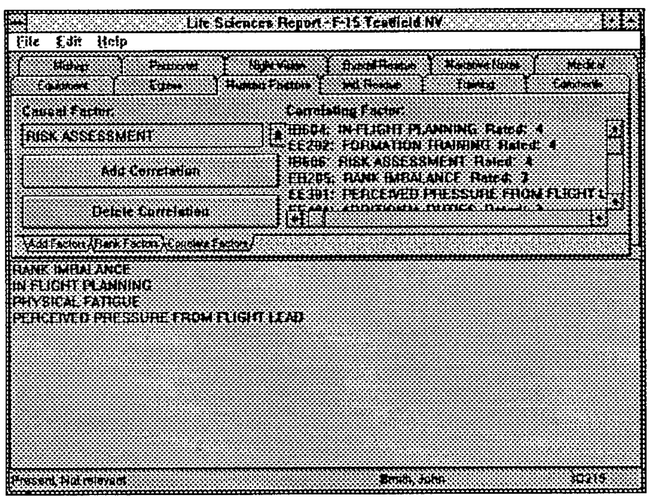
Ratings: 0-Present, not relevant 1-Minimal contribution 2-Minor contribution 3-Major contribution 4- Causal



The factors you select will be displayed in the lower part of the screen with a scroll bar if necessary. The factors will be listed with their rating. To delete a factor, click on the factor to be deleted in the lower part of the screen then click on the "Delete" tab.



The next step in the "Human Factors" screen is to rank factors that are rated "4". Click on the "Rank Factors" tab to obtain the screen like the one to the left. The factors rated "4" will automatically be displayed in the top box. Arrange these factors by clicking on a factor to be moved and then clicking the "Move Up" or "Move Down" button until the factor is in the appropriate position. The factors should be arrange from most important at the top to least important at the bottom. When in the right order click on the button labeled " Save Ranking."



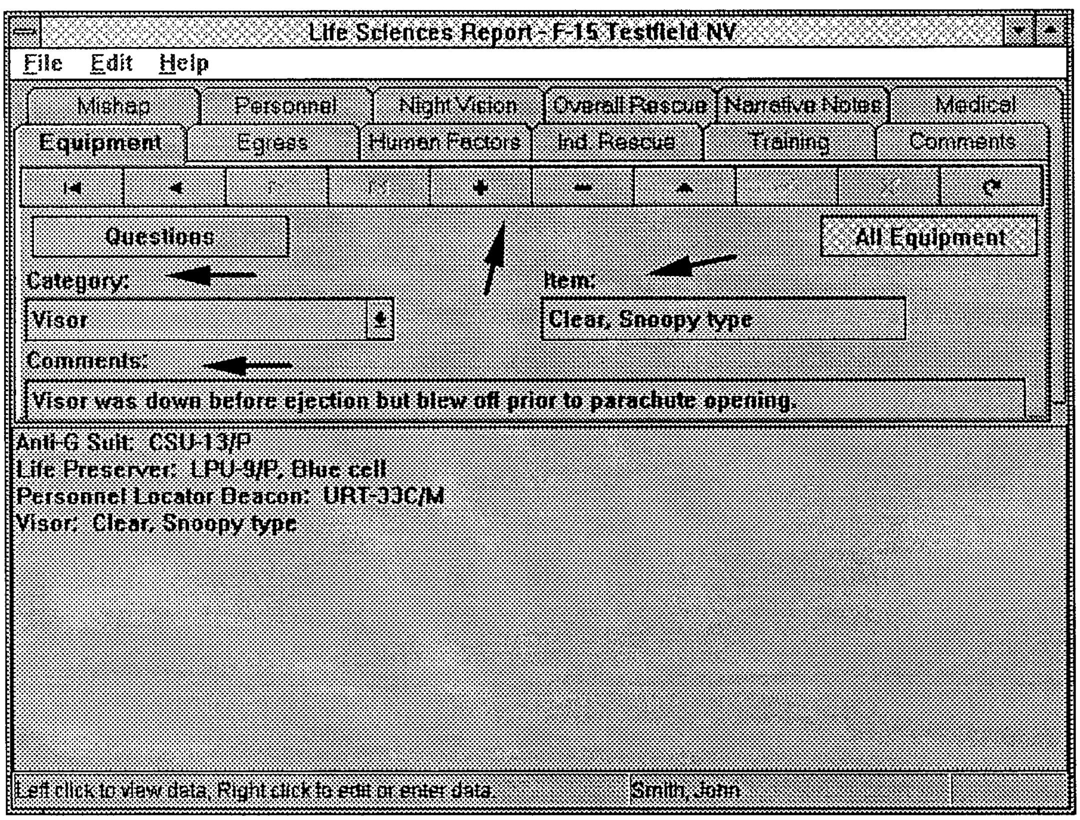
The last step in the "Human Factors" screen is to correlate factors. Click on the "Correlate Factors" tab. The pull down list contains only the factors rated "4" since only 4s can have other factors correlated with them. For each factor rated "4" that you determine have related factors, select those related factors from the list on the upper right. Click on the most important correlating factor, in the box in the upper right, to the Causal Factor, displayed in the upper left. Continue identifying factors in descending order of importance. Remember it is <u>not</u> mandatory that all Causal Factors have Correlating Factors nor that all factors from the list be used. Note: Causal Factors can be correlated to other causal

factors and factors from the list can be used as a Correlating Factor with more than one Causal Factor.

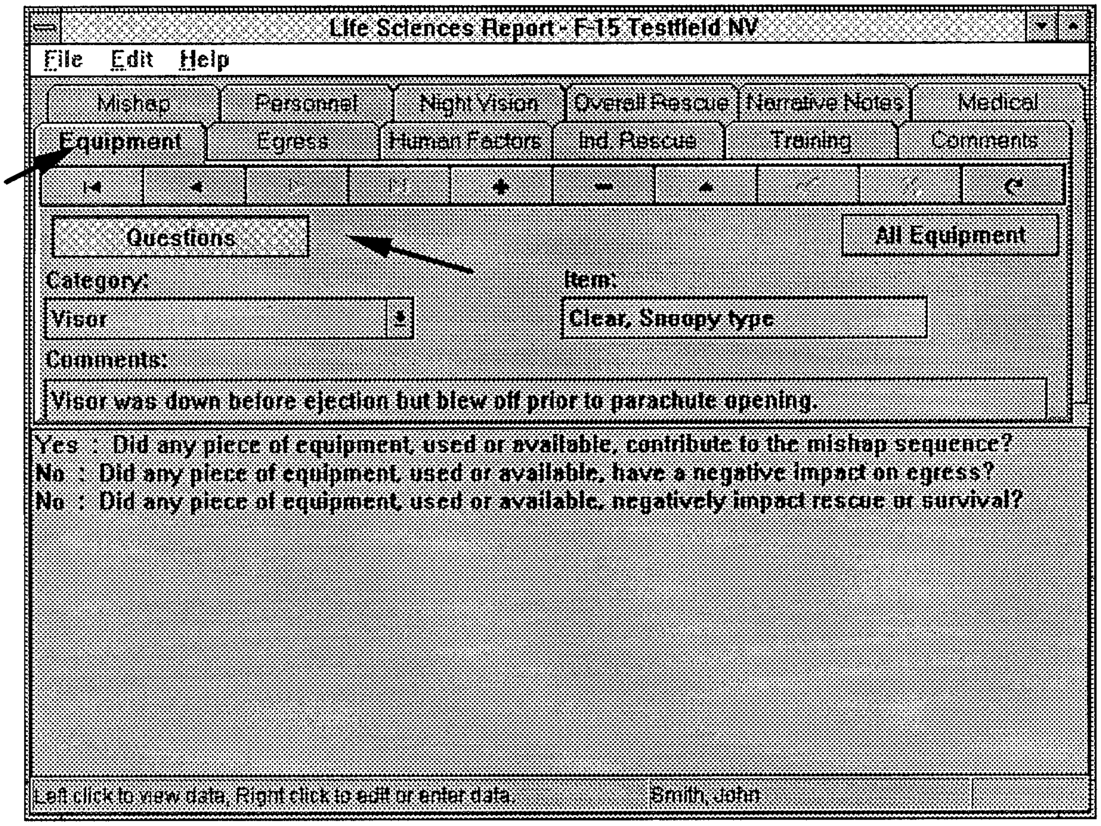
NOTE: After left clicking on the "Add or Delete Correlation" button the first left click back on the list of factors may not highlight the factor you expect. This is because the first click returns you to the list; you may need to click on a factor a second time to highlight it for correlation.

The "Equipment" screen is fairly simple but the following hints may be helpful. "Category" of life support equipment is picked from a pull-down list. "Item" & "Comments" are free form entry fields. "Item" should be filled in with the nomenclature used to order an exact duplicate of the equipment. "Comments" is limited to 255 characters, however, a full discussion of the problems with the equipment listed here is mandatory in Tab Y. List all equipment that was a problem in this mishap through rescue and recovery. List related equipment problems to primary equipment problems when appropriate, e.g., if visor was blown off of the helmet then also pick helmet from the pull-down category list and identify the helmet in the "Item" area and make appropriate comments.

Use the "+" button to add a new piece of equipment to the list. Be careful, changing the "Category" entry without clicking on the "+" button may cause a mismatch between "Category" and the "Item" & "Comments" since changing "Category" <u>does not</u> start a new entry. Remember, opening the pull down list for "Category" does not start the next entry only the "+" button does.



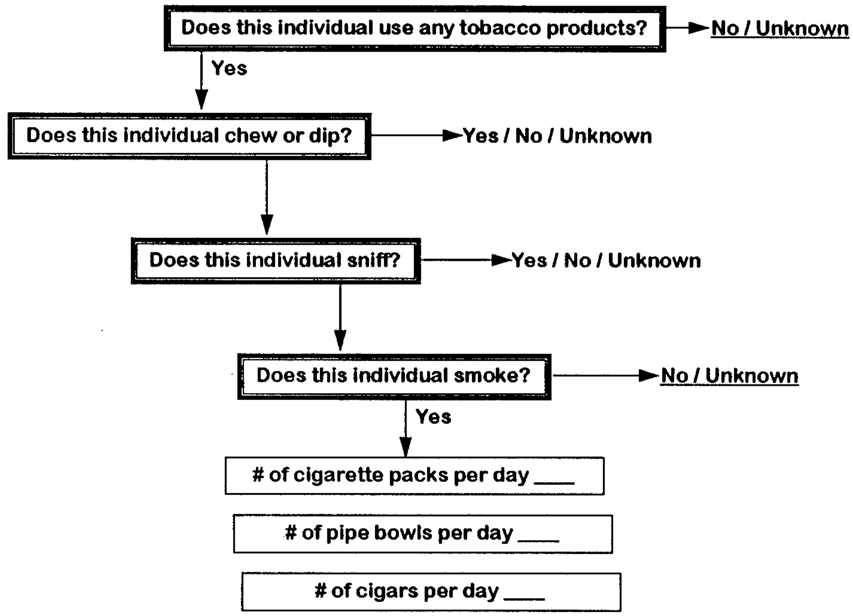
Also on the "Equipment" screen is a button labeled "Questions". Left clicking on this button will show the questions and answers in the lower part of the screen if you have previously answered the questions. Right clicking on the "Questions" button will open a small window box that has four choices: View, Change, Add or Cancel as described on P-4.



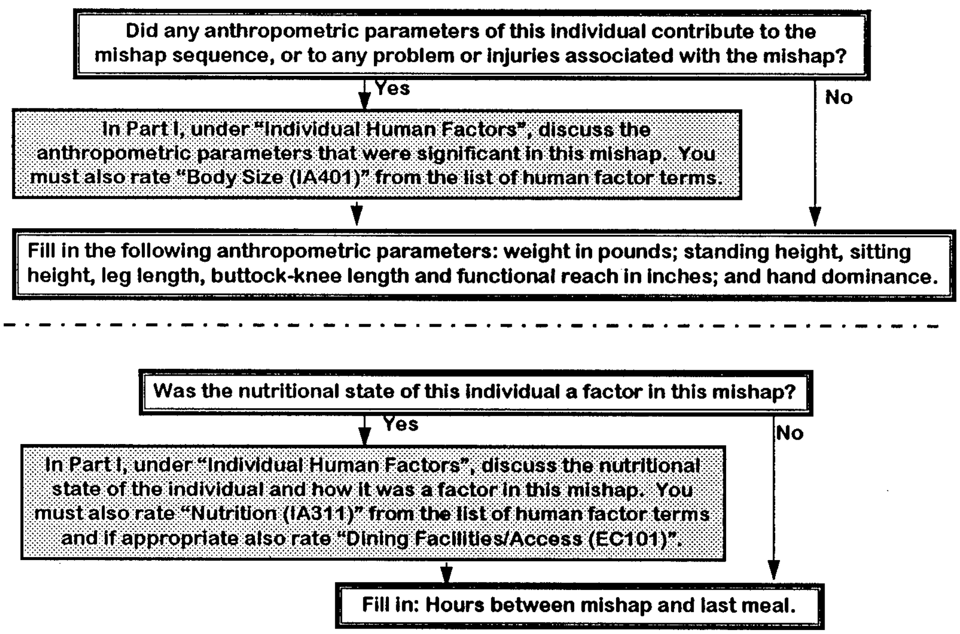
The other tabs are relatively easier to negotiate. They all follow the same rules of right and left clicking. Notice that in the "Egress" screen that only two buttons originally appear when opening that tab. However, a series of other buttons will appear depending on your answers to the initial egress questions. Also note that "Overall Rescue" tab and the "Aircraft NVD" button in the "Night Vision" tab have questions that relate to the entire mishap and need to be input only once regardless of how many people were involved in the mishap.

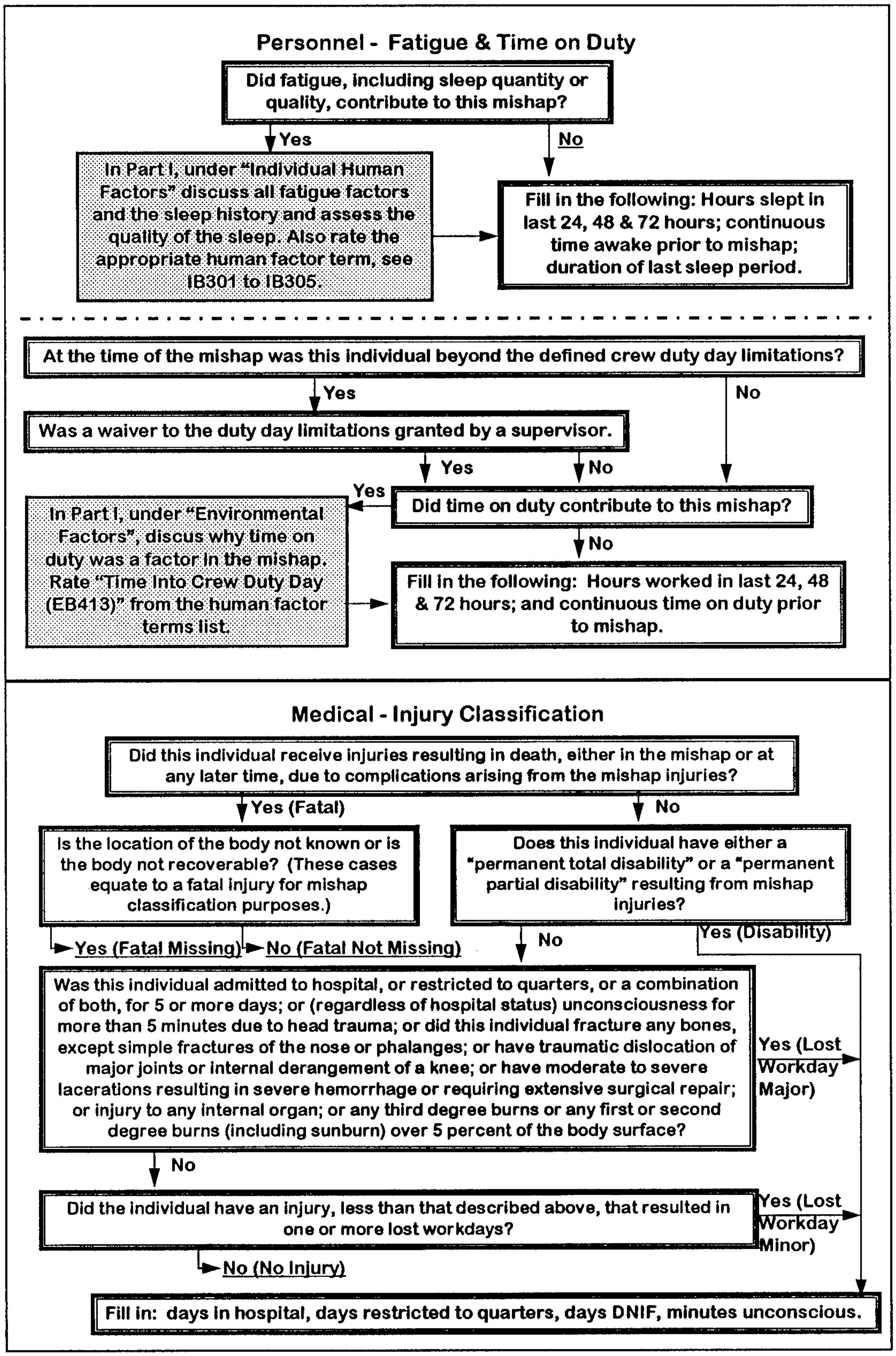
The following pages contain the logic flow diagrams on which the above computer program was based.

Personnel - Smoking

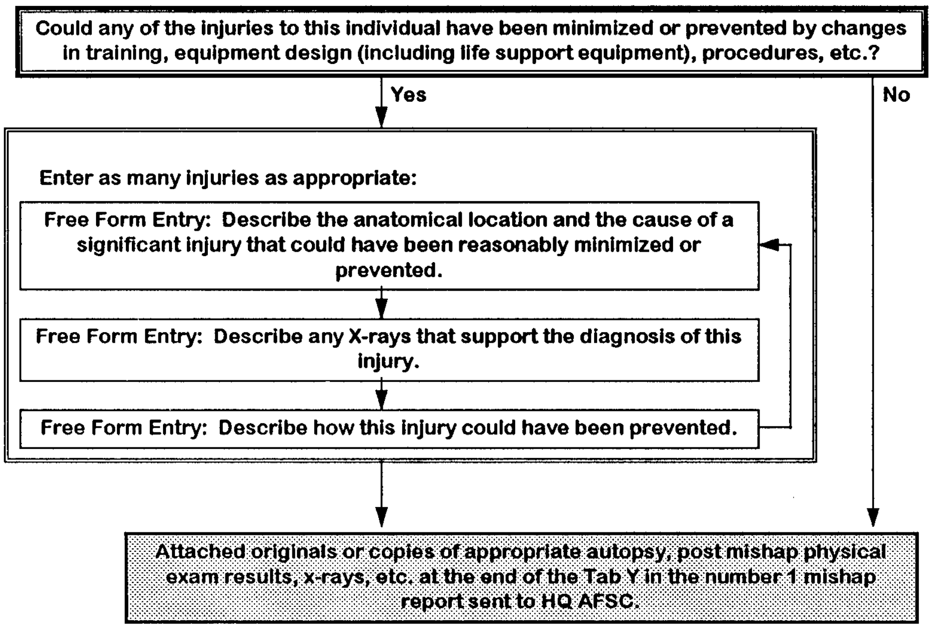


Personnel - Anthropometric & Nutritional

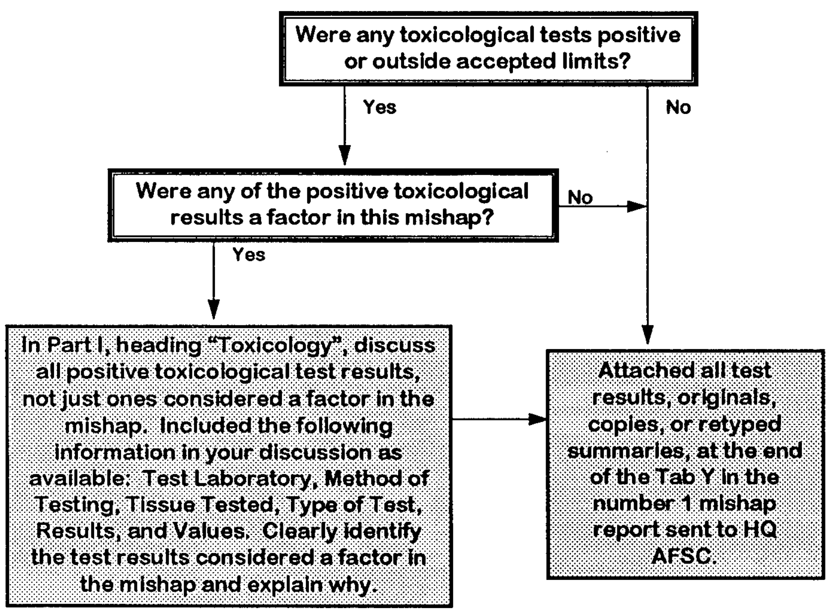



Personnel - Fatigue & Time on Duty
Did fatigue, including sleep quantity or quality, contribute to this mishap?
Yes
No
In Part I, under "Individual Human Factors" discuss all fatigue factors and the sleep history and assess the quality of the sleep. Also rate the appropriate human factor term, see IB301 to IB305.
Fill in the following: Hours slept in last 24, 48 & 72 hours; continuous time awake prior to mishap; duration of last sleep period.
At the time of the mishap was this individual beyond the defined crew duty day limitations?
Yes
No
Was a waiver to the duty day limitations granted by a supervisor.
Yes
No
Yes
Did time on duty contribute to this mishap?
No
In Part I, under "Environmental Factors", discus why time on duty was a factor in the mishap. Rate "Time Into Crew Duty Day (EB413)" from the human factor terms list.
Fill in the following: Hours worked in last 24, 48 & 72 hours; and continuous time on duty prior to mishap.
Medical - Injury Classification
Did this individual receive injuries resulting in death, either in the mishap or at any later time, due to complications arising from the mishap injuries?
Yes (Fatal)
No
Is the location of the body not known or is the body not recoverable? (These cases equate to a fatal injury for mishap classification purposes.)
Does this individual have either a "permanent total disability" or a "permanent partial disability" resulting from mishap injuries?
Yes (Fatal Missing)
No (Fatal Not Missing)
No
Yes (Disability)
Was this individual admitted to hospital, or restricted to quarters, or a combination of both, for 5 or more days; or (regardless of hospital status) unconsciousness for more than 5 minutes due to head trauma; or did this individual fracture any bones, except simple fractures of the nose or phalanges; or have traumatic dislocation of major joints or internal derangement of a knee; or have moderate to severe lacerations resulting in severe hemorrhage or requiring extensive surgical repair; or injury to any internal organ; or any third degree burns or any first or second degree burns (including sunburn) over 5 percent of the body surface?
Yes (Lost Workday Major)
No
Did the individual have an injury, less than that described above, that resulted in one or more lost workdays?
Yes (Lost Workday Minor)
No (No Injury)
Fill in: days in hospital, days restricted to quarters, days DNIF, minutes unconscious.

Medical - Injuries & X-rays



Medical - Toxicological



Medical - Physical, Pre-exiting Disease, & 3/14 Day History

Did this individual have an appropriate, current (normally within one year) physical?

Yes

No

Did the lack of an appropriate, current physical contribute to this mishap?

Yes

No

In Part I, under "Physical Examination", explain the reasons for the lack of a physical and explain how the lack of the physical was a factor in this mishap.

Did this individual have any diseases(s) at the time of the mishap? This includes undocumented, documented, unwaived and waived diseases.

Yes

No

Was / Were the disease(s) a factor in this mishap?

Yes

No

In Part I, under "Pre-Existing Disease", discuss all pre-existing diseases. Describe the condition, list the USAFSAM consultation dates, and list the SG waiver dates. Clearly identify which, if any, of the diseases listed was a factor in the mishap and explain why.

Were there any significant events or issues in this individual's 3 or 14 day histories that were a factor in this mishap?

Yes

In Part I, under "3 / 14 day History", discuss only significant events or issues for this individual.

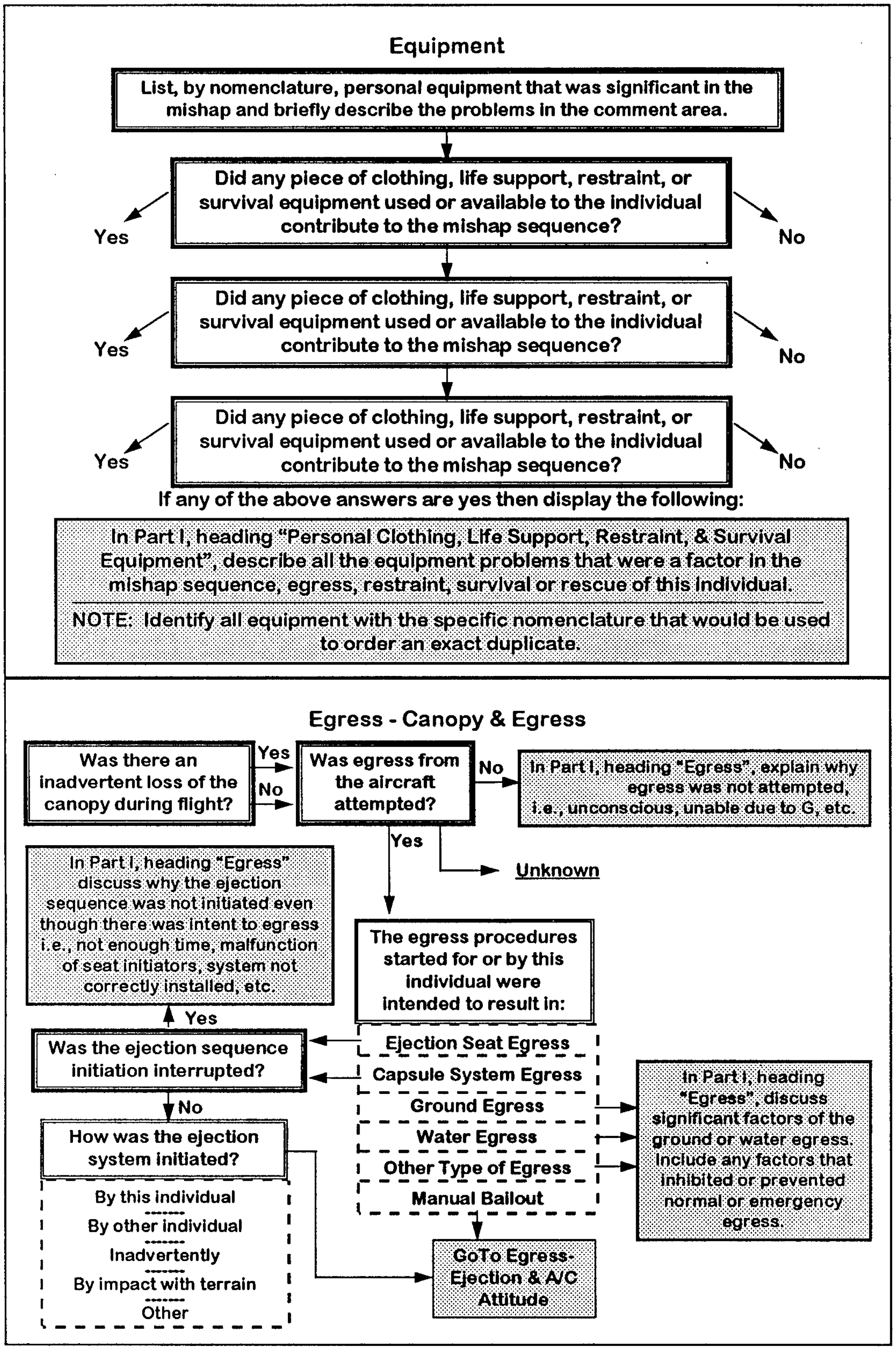
No

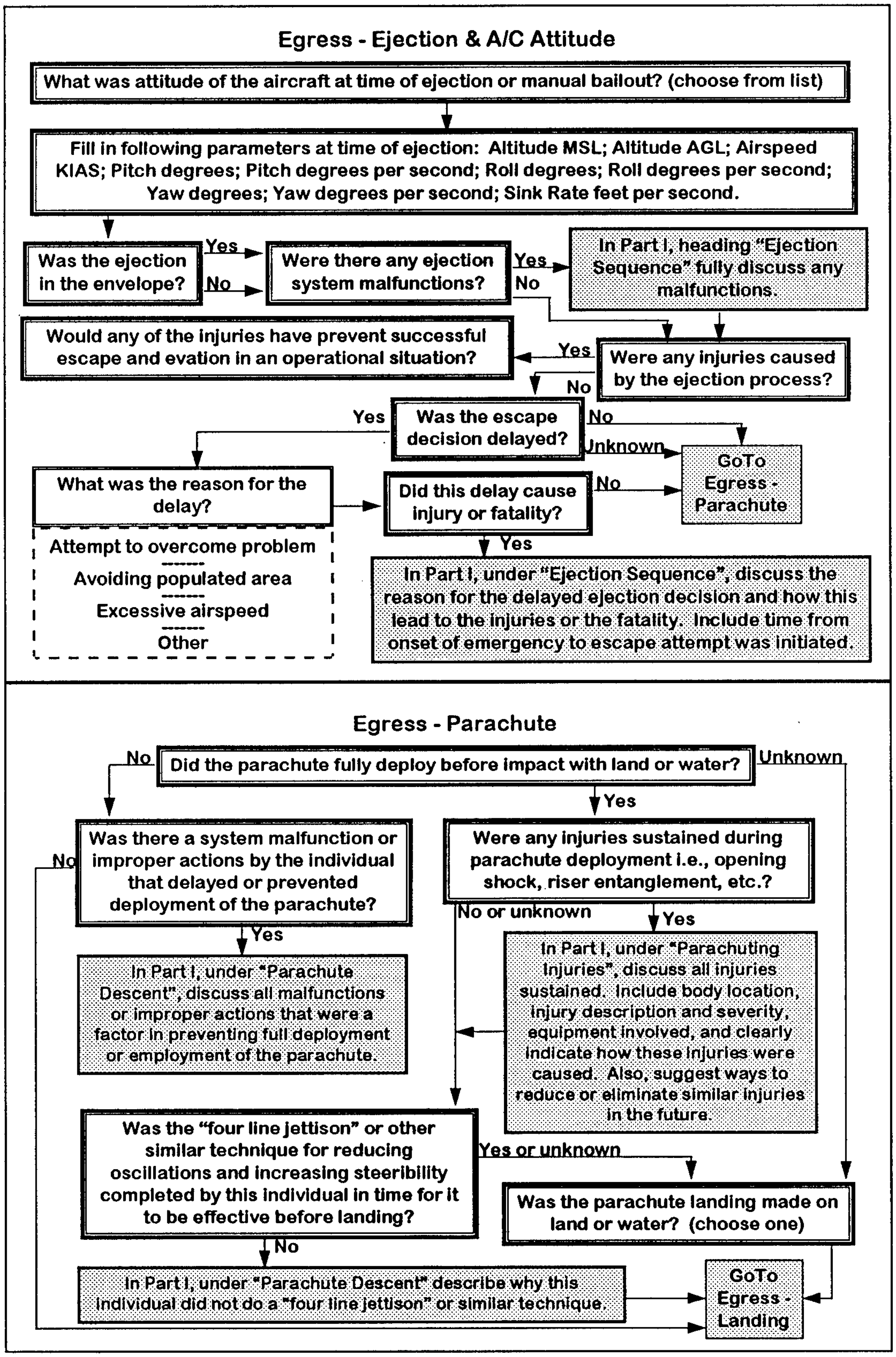
Human Factors - Rate Factors, Rank "4's", & Build Matrix

- Rate human factors involved in mishap on a scale from 0 to 4
  - 0 = present but not relevant
  - 1 = Minimal Contribution
  - 2 = Minor Contribution
  - 3 = Major Contribution
  - 4 = Causal
- Rank "4s" from most to least important in mishap
- Build correlation matrix

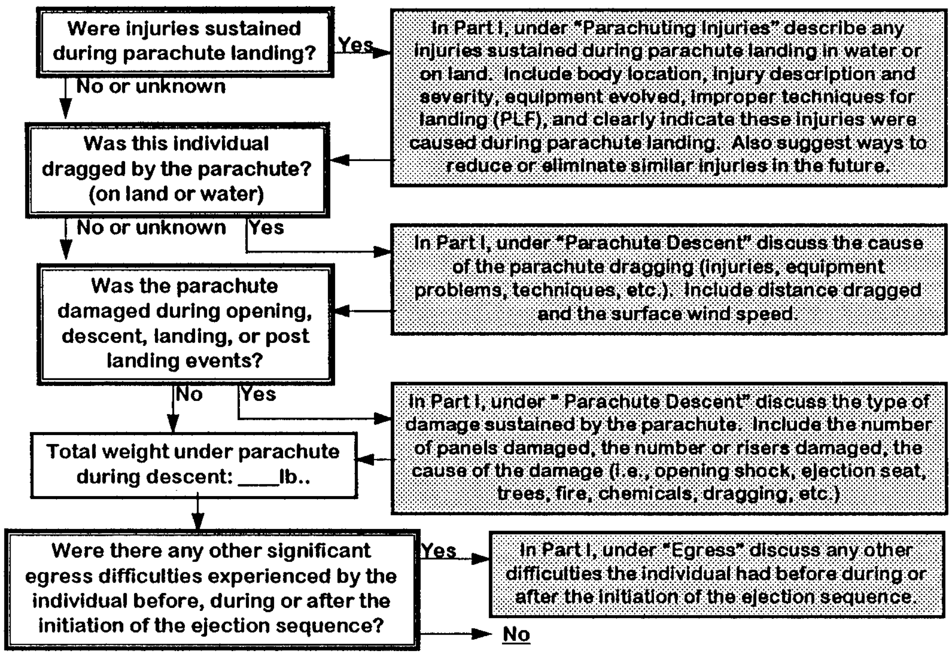
	#1 related factor	#2 related factor	#3 related factor	#4 related factor	etc.
#1 factor rated "4"					
#2 factor rated "4"					
#3 factor rated "4"					
#4 factor rated "4"					
etc.					

Note: Use only factors that were rated. Factors may be used only once in a row, but can be used more than once if placed in different rows.

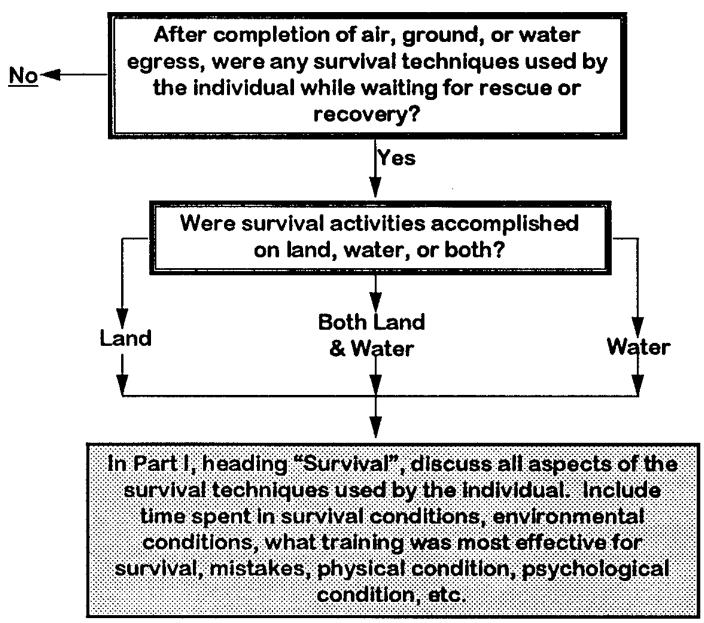

Equipment
List, by nomenclature, personal equipment that was significant in the mishap and briefly describe the problems in the comment area.
Did any piece of clothing, life support, restraint, or survival equipment used or available to the individual contribute to the mishap sequence?
Yes
No
Did any piece of clothing, life support, restraint, or survival equipment used or available to the individual contribute to the mishap sequence?
Yes
No
Did any piece of clothing, life support, restraint, or survival equipment used or available to the individual contribute to the mishap sequence?
Yes
No
If any of the above answers are yes then display the following:
In Part I, heading "Personal Clothing, Life Support, Restraint, & Survival Equipment", describe all the equipment problems that were a factor in the mishap sequence, egress, restraint, survival or rescue of this individual.
NOTE: Identify all equipment with the specific nomenclature that would be used to order an exact duplicate.
Egress - Canopy & Egress
Was there an inadvertent loss of the canopy during flight?
Yes
No
Was egress from the aircraft attempted?
No
In Part I, heading "Egress", explain why egress was not attempted, i.e., unconscious, unable due to G, etc.
Yes
Unknown
In Part I, heading "Egress" discuss why the ejection sequence was not initiated even though there was intent to egress i.e., not enough time, malfunction of seat initiators, system not correctly installed, etc.
The egress procedures started for or by this individual were intended to result in:
Yes
Was the ejection sequence initiation interrupted?
Ejection Seat Egress
Capsule System Egress
Ground Egress
Water Egress
Other Type of Egress
Manual Bailout
In Part I, heading "Egress", discuss significant factors of the ground or water egress. Include any factors that inhibited or prevented normal or emergency egress.
No
How was the ejection system initiated?
By this individual
By other individual
Inadvertently
By impact with terrain
Other
GoTo Egress-Ejection & A/C Attitude


Egress - Ejection & A/C Attitude
What was attitude of the aircraft at time of ejection or manual bailout? (choose from list)
Fill in following parameters at time of ejection: Altitude MSL; Altitude AGL; Airspeed KIAS; Pitch degrees; Pitch degrees per second; Roll degrees; Roll degrees per second; Yaw degrees; Yaw degrees per second; Sink Rate feet per second.
Was the ejection in the envelope?
Yes
No
Were there any ejection system malfunctions?
Yes
No
In Part I, heading "Ejection Sequence" fully discuss any malfunctions.
Would any of the injuries have prevent successful escape and evation in an operational situation?
Yes
Were any injuries caused by the ejection process?
No
Yes
Was the escape decision delayed?
No
Unknown
GoTo Egress - Parachute
What was the reason for the delay?
Attempt to overcome problem
Avoiding populated area
Excessive airspeed
Other
Did this delay cause injury or fatality?
No
Yes
In Part I, under "Ejection Sequence", discuss the reason for the delayed ejection decision and how this lead to the injuries or the fatality. Include time from onset of emergency to escape attempt was initiated.
Egress - Parachute
No
Did the parachute fully deploy before impact with land or water?
Unknown
Yes
Was there a system malfunction or improper actions by the individual that delayed or prevented deployment of the parachute?
No
Yes
In Part I, under "Parachute Descent", discuss all malfunctions or improper actions that were a factor in preventing full deployment or employment of the parachute.
Were any injuries sustained during parachute deployment i.e., opening shock, riser entanglement, etc.?
No or unknown
Yes
In Part I, under "Parachuting Injuries", discuss all injuries sustained. Include body location, injury description and severity, equipment involved, and clearly indicate how these injuries were caused. Also, suggest ways to reduce or eliminate similar injuries in the future.
Was the "four line jettison" or other similar technique for reducing oscillations and increasing steeribility completed by this individual in time for it to be effective before landing?
Yes or unknown
No
Was the parachute landing made on land or water? (choose one)
In Part I, under "Parachute Descent" describe why this individual did not do a "four line jettison" or similar technique.
GoTo Egress - Landing

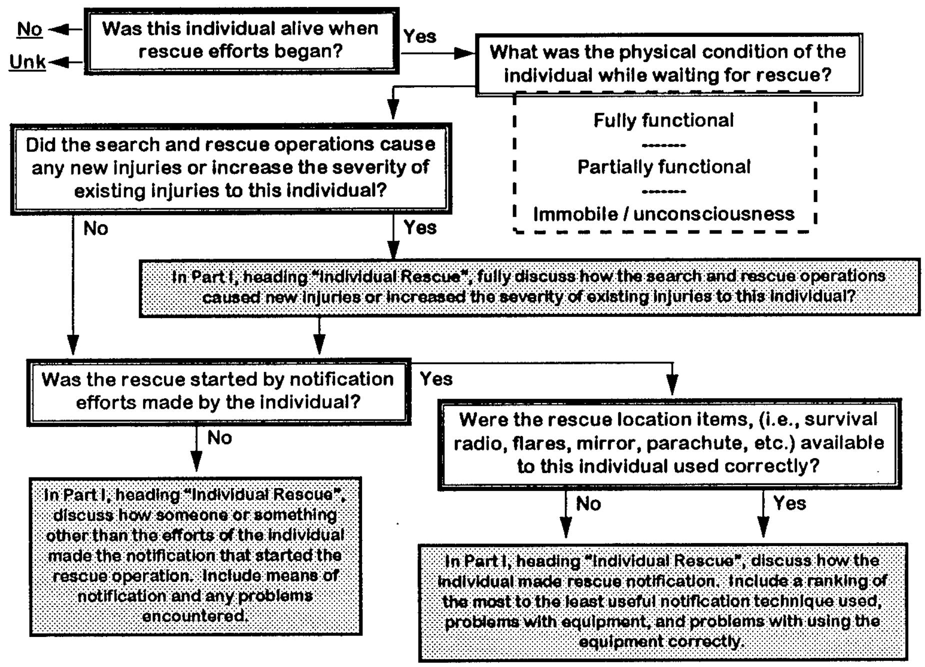
Egress - Landing



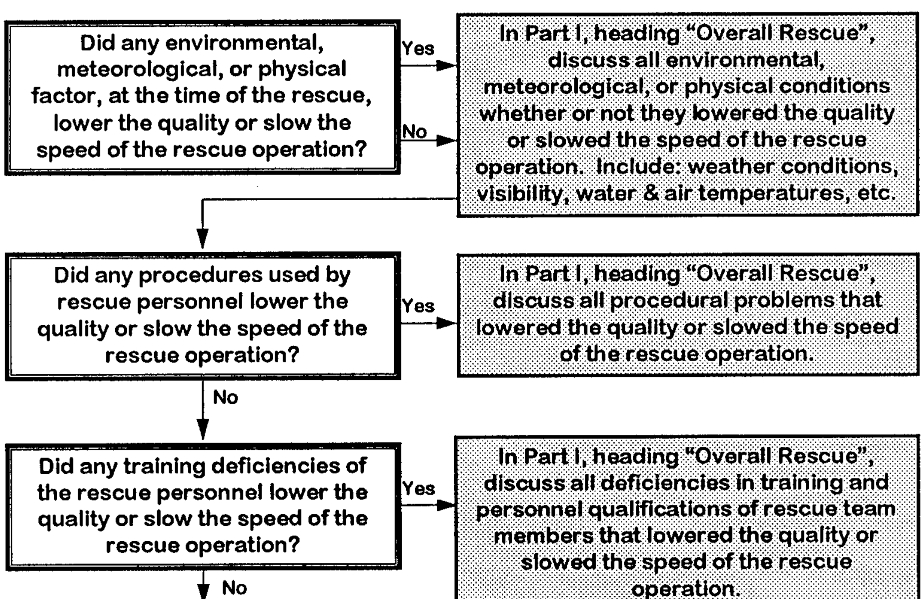
Egress - Survival



Individual Rescue - Rescue & Recovery



Overall Rescue - Rescue & Recovery 1



Continued: Overall - Rescue / Recovery 2

Overall Rescue - Rescue & Recovery 2

Continued from: Overall - Rescue / Recovery 1

The total time from mishap occurrence to notification of rescue personnel:_____mins.

The total time from mishap occurrence to when the last individual was actually aboard a rescue vehicle:_____mins.

The total time from mishap occurrence to rescue completed [individual(s) returned to station, hospital, etc.] or rescue abandoned:_____mins.

What was the first rescue vehicle to arrive at the mishap site?

- Military
- Civilian
- Foreign Military
- Foreign Civilian
- None

- Helicopter
- Ambulance
- Crash/Fire Rescue Vehicle
- Standard Vehicle
- Other

What what was the primary rescue vehicle used during the rescue?

- Military
- Civilian
- Foreign Military
- Foreign Civilian
- None

- Helicopter
- Ambulance
- Crash/Fire Rescue Vehicle
- Standard Vehicle
- Other

Training

Was this individual lacking or delinquent in any required Human Factor or Life Support training?

Yes → In Part I, heading "Training", discuss what training was lacking or delinquent and why. Also discuss how this missing training effected the mishap.

No

Did any completed training courses provide training that was used or could have been used by this individual during the mishap sequence, egress, survival, or rescue?

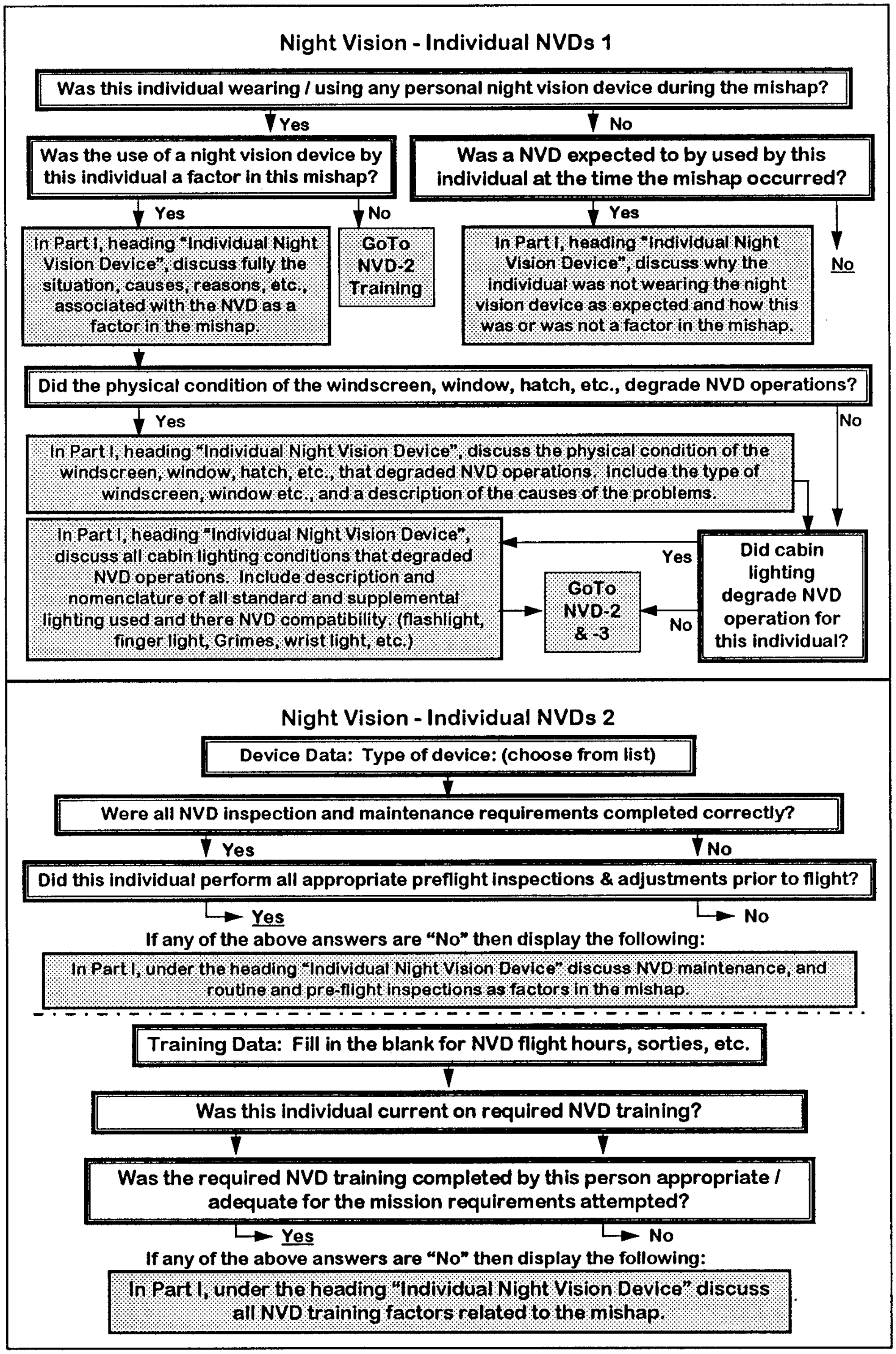
Yes → In Part I, heading "Training", list the courses and discuss specifically the training that was used or could have been used by this individual during the mishap sequence, egress, survival, or rescue.

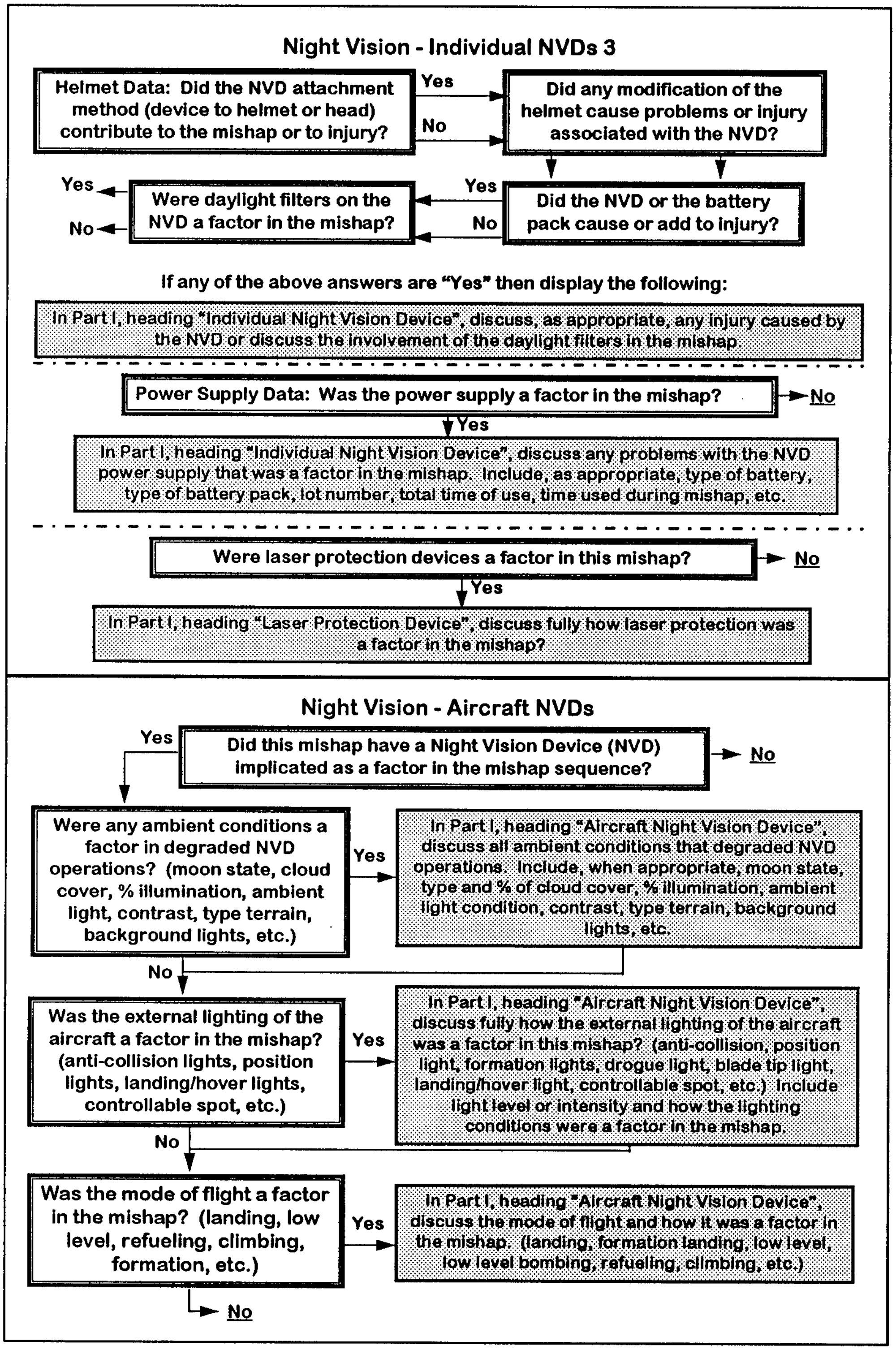
No

Did the individual complete any non-required courses that provided training that was used during the mishap sequence, egress, survival, or rescue?

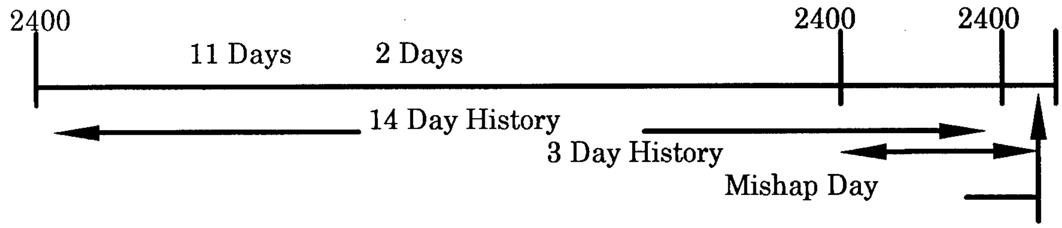
Yes → In Part I, heading "Training", discuss non-required training completed by this individual and how they impacted the mishap sequence, egress, survival, or rescue. Include positive and negative effects and any other relevant details about the training.

No


Night Vision - Individual NVDs 1
Was this individual wearing / using any personal night vision device during the mishap?
Yes
No
Was the use of a night vision device by this individual a factor in this mishap?
Was a NVD expected to by used by this individual at the time the mishap occurred?
Yes
No
Yes
No
In Part I, heading "Individual Night Vision Device", discuss fully the situation, causes, reasons, etc., associated with the NVD as a factor in the mishap.
GoTo NVD-2 Training
In Part I, heading "Individual Night Vision Device", discuss why the individual was not wearing the night vision device as expected and how this was or was not a factor in the mishap.
Did the physical condition of the windscreen, window, hatch, etc., degrade NVD operations?
Yes
No
In Part I, heading "Individual Night Vision Device", discuss the physical condition of the windscreen, window, hatch, etc., that degraded NVD operations. Include the type of windscreen, window etc., and a description of the causes of the problems.
In Part I, heading "Individual Night Vision Device", discuss all cabin lighting conditions that degraded NVD operations. Include description and nomenclature of all standard and supplemental lighting used and there NVD compatibility. (flashlight, finger light, Grimes, wrist light, etc.)
Yes
GoTo NVD-2 & -3
No
Did cabin lighting degrade NVD operation for this individual?
Night Vision - Individual NVDs 2
Device Data: Type of device: (choose from list)
Were all NVD inspection and maintenance requirements completed correctly?
Yes
No
Did this individual perform all appropriate preflight inspections & adjustments prior to flight?
Yes
No
If any of the above answers are "No" then display the following:
In Part I, under the heading "Individual Night Vision Device" discuss NVD maintenance, and routine and pre-flight inspections as factors in the mishap.
Training Data: Fill in the blank for NVD flight hours, sorties, etc.
Was this individual current on required NVD training?
Was the required NVD training completed by this person appropriate / adequate for the mission requirements attempted?
Yes
No
If any of the above answers are "No" then display the following:
In Part I, under the heading "Individual Night Vision Device" discuss all NVD training factors related to the mishap.


Night Vision - Individual NVDs 3
Helmet Data: Did the NVD attachment method (device to helmet or head) contribute to the mishap or to injury?
Yes
No
Did any modification of the helmet cause problems or injury associated with the NVD?
Did the NVD or the battery pack cause or add to injury?
Yes
No
Were daylight filters on the NVD a factor in the mishap?
Yes
No
If any of the above answers are "Yes" then display the following:
In Part I, heading "Individual Night Vision Device", discuss, as appropriate, any injury caused by the NVD or discuss the involvement of the daylight filters in the mishap.
Power Supply Data: Was the power supply a factor in the mishap?
No
Yes
In Part I, heading "Individual Night Vision Device", discuss any problems with the NVD power supply that was a factor in the mishap. Include, as appropriate, type of battery, type of battery pack, lot number, total time of use, time used during mishap, etc.
Were laser protection devices a factor in this mishap?
No
Yes
In Part I, heading "Laser Protection Device", discuss fully how laser protection was a factor in the mishap?
Night Vision - Aircraft NVDs
Did this mishap have a Night Vision Device (NVD) implicated as a factor in the mishap sequence?
Yes
No
Were any ambient conditions a factor in degraded NVD operations? (moon state, cloud cover, % illumination, ambient light, contrast, type terrain, background lights, etc.)
Yes
In Part I, heading "Aircraft Night Vision Device", discuss all ambient conditions that degraded NVD operations. Include, when appropriate, moon state, type and % of cloud cover, % illumination, ambient light condition, contrast, type terrain, background lights, etc.
No
Was the external lighting of the aircraft a factor in the mishap? (anti-collision lights, position lights, landing/hover lights, controllable spot, etc.)
Yes
In Part I, heading "Aircraft Night Vision Device", discuss fully how the external lighting of the aircraft was a factor in this mishap? (anti-collision, position light, formation lights, drogue light, blade tip light, landing/hover light, controllable spot, etc.) Include light level or intensity and how the lighting conditions were a factor in the mishap.
No
Was the mode of flight a factor in the mishap? (landing, low level, refueling, climbing, formation, etc.)
Yes
In Part I, heading "Aircraft Night Vision Device", discuss the mode of flight and how it was a factor in the mishap. (landing, formation landing, low level, low level bombing, refueling, climbing, etc.)
No

Part I of Narrative [part1.doc] Include only events investigated and found to be a factor in the mishap sequence, egress, survival, or rescue. <u>Do not</u> include negative or rule out discussions. Part I should include a discussion of all the notes generated by filling out the Life Science Report program (see Life Science Report below) but is not limited to a discussion of only those factors if in your investigation you found other factors not indicated in the Life Science Report that were factors in the mishap. Also include any items which were significant to the mishap in the 3 and 14 day history for any individuals involved in the mishap. The histories should contain only the significant events and contextual entries. Note: The individual's 3 & 14 day history should be investigated fully, however, only report events that are significant to the mishap. If you are not sure of the significance of an event or activity report it and explain in the significance column (see 3 & 14 day example format). *Findings and recommendations, from Part I, determined to be significant must also be discussed and incorporated into appropriate sections of Tab T and included in Tab T findings and recommendations as appropriate.*
Part II of Narrative [part2.doc] Include only events <u>investigated and found NOT to be a factor</u> in the mishap sequence, egress, survival, or rescue. Negative or rule out discussions may be included in this part if determined by the investigator as necessary to document for readers that potential factors were fully investigated before being ruled out. Also Part II should contain discussions of life science and life support factors that, although not a factor in this mishap, could be predisposing to future mishaps. *Findings and recommendations of other significance, from Part II, must also be discussed and incorporated into appropriate sections of Tab T and included in Tab T findings and recommendations of other significance as appropriate.*
HF Consultant Reports [hf.doc] When available place all human factor consultant reports here.
Life Science Report *(printed from LSR software)* Tab Y, Section 3 Produce a report on each individual who was a primary crewmember or was a factor in the mishap sequence, or experienced a problem during egress, survival, or rescue.
Physicals Include physicals for the aircraft's rated primary crew and for anyone else who was identified as causal in the mishap. For these individuals put copies of their last two physicals, if one is long, or else their last three physicals in the number 1 mishap report sent to HQ AFSC.
Other Reports and Appendices TOX tests, post mishap exam results, list of injuries, autopsy results, x-rays, and any other reports that support findings or recommendations made by the medical investigator. NOTE: These documents may be originals, copies, or a retyped summary of the originals. Include these documents only in the number 1 mishap report sent to HQ AFSC



3 Day History for Capt John Jones (MP2)- significant events only

Date 04-JUL		2 days before mishap day - 3 Day History
Time:	Event:	Significance:
0400	Woke up	Only 6 hours of crew rest
2100	Went to sleep - start crew rest	Context *(entry for clarity only)*

Date 03-JUL		1 days before mishap day - 3 Day History
Time:	Event:	Significance:
0400	Woke up	Only 7 hours of crew rest
0930	Went to sleep - start crew rest	Context

Date 02-JUL		mishap day - 3 Day History
Time:	Event:	Significance:
0130	Son, 3 years old, woke up crying with a fever and an ear infection waking up MP2	MP2 was 4 hours into his crew rest. This disrupted his normal sleep routine.
0230	MP2 went back to sleep	Context
0430	MP2 woke up	This two hour rest period was described by the spouse to be "very restless" for MP2 he was turning and repositioning in the bed continually Required crew rest was not completed and the quality of that rest was less than optimal. Only 6 hours of combined crew rest time.
0545	At squadron for preflight briefing	Begin duty day
1215	Step	Mission delayed from scheduled 0900 step
1310	Take off	Context
1420	Mishap	At end of normal duty period. Fatigue is a major contributor to this mishap

14 Day History for Capt John Jones (MP2)- significant events only

14 Day History		
Date	Event:	Significance:
18 JUN	Maj's promotion list released	Promoted one year BLZ - MP2 did not expect promotion - extremely elated
25 JUN	Sister died after long illness	Did not appear to affect MP2 but possibly could have.

Chapter VI

Future Training and Education Options

Human Factors Investigator (HFI) Training and Education Options

As discussed in Chapter III, the background and training of the human factors investigator varies widely among the NATO countries. WG-23 determined that human factors expertise, beyond that included in basic flight surgeon courses, was needed to ensure complete investigation of human factors issues.

This chapter is a discussion of options for the selection, training, credentialing and certification of individuals to be human factor mishap investigators in the future. Emphasis should be focused on the term "options", since several ideas will be discussed as possible directions to follow in the future. The ideas presented here for the training of HFIs may not represent the best solutions. However, these ideas may stimulate discussion of how to prepare HFIs in countries that are currently using HFIs in mishap investigation or will be using them in the future.

The area of "human factors" is not well defined, especially when it comes to aviation and aircraft mishap investigation. Mishaps are usually divided into two very broad categories, one being human error or operations mishaps and the other logistic or mechanical mishaps. However, at the extreme, every mishap is actually a "human factors" mishap. The division of mishaps into two or more categories is somewhat arbitrary. The category labeled as "human factors" or "operatinal" usually includes those mishaps that are atarted by a human factor, or human error by one of the primary aircrew or by supervision.

The reason for the above discussion about "what is categorized as a human factor mishap" is to show the potential scope and the potential confusion in determining what background is desired or required in a person selected to go into human factors investigation. What academic background is desired or required? What field experience is desired or required? These are questions whose answers depend on how human factors mishap are defined. In other words, " How far back into all the processes leading to the mishap is the human factors investigator required to go?".

From a practical standpoint, the individual being considered to become a human factor investigator should have an academic background in aerospace medicine, aerospace physiology, or psychology and should have significant flightline related work experience. Also, it would be desirable for the individual to have observed an experienced human factors investigator conducting a mishap investigation.

The human factors investigator does not have to be an expert in all aeras of human factors. If that was a requirement, then it is likely that no one would be qualified to be a HFI. However, the HFI needs to have: (1) a broad understanding of the different aspects of human factors; (2) the ability to recognize when specific haman factors expertise is needed and then obtain it; (3) the communication skills to work effectively with other investigators on a mishap; and (4) the ability to effectively record , in narrative format, the human factors interactions in the events precipitating the mishap.

Most NATO countrieshave programs that train individuals in the procedures for general aircraft mishap investigation. These programs do cover aspect of haman factors investigation. However , they are dedicated mainly to the education of the rated safety officer, concentrating on the areas of prevention, investigation, and safety regulations and procedures. While it is useful for the haman factors investigator (HFI) to attend these types of courses, they still do not have the depth of information thatr would significantly increase the effectiveness of the HFI. Germany conducts extensive and effective courses in flight safety for its flight safety officers, flight safety NCOs, and for Commanders. The US Air Force provides similar courses for its safety personnel , however, recently the US medical training community has been conducting a training program specifically designed for the HFI.

Selecting individuals with the right background and skills to bacome competent HFIs may be the easy step. The more difficult steps are: one, providing these individuals with an effective training program specifically pointed at making them a "certified" HFI; and two, keeping these individuals for a reasonable number of years in a cadre of readily available investigators.

The following are some potential training options that can be used to certify a HFI.

Option 1-- On the job training (individual may be primary investigator in the first mishap they attend)

In the past this was the technique used by most, if not all, NATO countries to "train" HFIs. This option is, obviously, the easiest to manage but with the lowest quality control.

Option 2-- Provide one HFI course, acceptable to NATO, that combines all the basic information needed to conduct a credible investigation. Also, this option should require investigation experience as an observer either before or after the formal training course.

Currently the Unites States Air Force has a course at Brooks AFB in Texas that provides this training. The course title is "Aircraft Mishap Investigation and Prevention" (AMIP). It is a two-week course that prepares flight surgeons, aerospace physiologists, and psychologists to be primary HFIs or consultants to safety investigation boards of aircraft mishaps. This course has also trained haman factors specialists from other countries. NATO should evaluate this course to determined if it should be a prerequisite for the NATO human factors investigator. This option is moderately difficult to manage for most NATO countries.

Option 3-- Each NATO country determines the course requirements for their HFIs. They can use courses created to meet their own needs or use existing courses in their country or other NATO counties. Also, this option should reequere investigations as an abserver either before, during, or after the formal training course.

Each country could use a combination of courses to train their HFIs to a level acceptable for their requirements. This option is easy to manage.

Whatever training regimen is finally followed, even an option significantly different than tthose presented above, there should be agreement among the NATO countries that training regimen is acceptable as producing a "certified" NATO HFI.

NATO countries should make every effort to assign a qualified NATO HFI to NATO related aircraft mishaps.

Appendix to Chapter VI

Human Factors Training Available in NATO Countries

Belgium

Sends pilots to "Institute Francais de Securite de Vol" in Paris, France. Also uses US and UK courses for training board members.

Canada

Aircraft Accident Investigation *DCIEM, Dir. Flight Safety*
Course taught to aviators and flight surgeons.

France

Aircraft Accident Investigation (2 weeks) Flight Safety Office of the French Air Force
For new people posted in an aircraft accident investigation job. Participants are mainly pilots, but also include mechanics and flight surgeons. Course covers aircraft accident investigation procedures, human factors and aeromedical lectures, technical lectures, and juridical aspects of aircraft accidents.

Germany

Flight Safety Officer, Basic Course (4 weeks) *Fürstenfeldbruck*
To enable the trainee to work as a squadron Flight Safety Officer, and to assist the wing Flight Safety Officer in matters of prevention, treatment and investigation of aircraft accidents.

Flight Safety Officer, Main Course (8 weeks) *Fürstenfeldbruck*
To enable the participant, to work as a full time Flight Safety Officer on all levels of command.

Flight Safety Meeting for Commanders (1 week) *Fürstenfeldbruck*
To extend and to deepen the Flight Safety Awareness of the Commanding Officers. To remind them that the responsibility for Flight Safety lies with them. To make them sensible for the interaction of the Man-Machine-Environment System

Italy

Aircraft Accident Prevention Course (2 weeks) *Rome*
For young officers, coming from all specialties. Provides safety education and enables officers to manage flight safety programs.

Aircraft Accident Investigation Course (9 weeks) *Rome*
For officers coming from Armed Forces. Instruction in aircraft accident investigation techniques and procedures and enable the participant to work as president or member of aircraft accident investigation boards.

Netherlands

Conducts training for aviators, medical, ground support and supervisory personnel. The training is the responsibility of the operations function.

Norway

No RNoAF courses in aviation accident investigation for HF specialists

Portugal

Conducts training for aviators, medical, ground support and supervisory personnel.

Spain

Conducts training for aviators, medical, and engineering personnel.
- 2-day seminar "Medical Aspects of Aircraft Accident Investigation"
- 5-week course for "Flight Safety Officers"

United Kingdom:

Air Line Crisis Management (3days) *Cranfield University*
How airlines deal with its passengers and crew, the victims, both alive and dead, of an international aircraft accident, and also with their friends and relatives while at the same time having to deal with the media and with business, political and other pressures resulting from the accident.

Aircraft Accident Investigation (6 weeks) *Cranfield University*
With assistance from the UK Air Accidents Investigation, many areas of aviation activity are evaluated and, in particular, the course provides a sound basic knowledge of all the requirements, procedures and techniques associated with accident investigation and prevention,. Several exercises are included, the final one being the thorough investigation and reporting of a simulated 'accident'.

Accident Investigation for Aircrew and Operations Executives (2 weeks) *Cranfield University*
With assistance from the UK Air Accidents Investigation, the needs of aircrew who may be involved in the operational and human factor aspects of the accident are developed. The aim is to bring together experienced people for discussion and evaluation of how accidents happen and, in particular, to provide them with a basic knowledge of accident investigation techniques and international procedures.

Safety Assessment of Aircraft Systems (1 week) *Cranfield University*
This sets out to discuss the various approaches to the problems of assessing the safety of increasingly complex aircraft systems and emphasis is placed on practical applications and design problems.

Flight Safety Officers Course *RAF*
Senior Officers Flight Safety Course *RAF*
These courses are aimed at station flight safety officers and provide information of all aspects of flight safety.

Supervision in Flying (3-10 days):
Flying Authorizers Course
Flying Supervisors Course
NATO Flying supervisors Course

Crew Resource Management Course *RAF*
The objective of CRM training is to use all available resources both technical and human to ensure safe and efficient flight operation and maintain proficiency in the most effective way.

United States Air Force

Flight Safety Officer (5 weeks) *Kirtland AFB, New Mexico*
Provides safety education for officers assigned to manage USAF flight safety programs. Objective is to provide students with a working knowledge of aircraft mishap investigation and aircraft mishap prevention procedures, policies, and techniques.

International Flight Safety Officer (10 weeks) *Kirtland AFB, New Mexico*
Safety education for officers assigned to manage flight safety programs. Provides students with an understanding of safety program management fundamentals, safety principles, and mishap investigation techniques. Course includes applied aerodynamics, engineering, communications, management, psychology, mishap prevention, and investigation.

Aircraft Mishap Investigation (2 weeks) *Kirtland AFB, New Mexico*
Trains officers and civilians in aircraft mishap investigation techniques and procedures; analyses of human and material factors involving aircraft systems and power plant. Curriculum is similar to investigative portion of Flight Safety Officer Course.

Safety Investigation Board President Course (1 week) *Kirtland AFB, New Mexico*
To introduce prospective Safety Investigation Board Presidents to the resources available to them and their board members during the investigation of the mishap. Provide techniques to understanding the "why" of the mishap. Discuss how to present the findings of the mishap in a convincing way that will generate actions to enhance flight safety.

Aircraft Mishap Investigation and Prevention Course (2 week) *Brooks AFB, Texas*
The course is intended for experienced flight surgeons, clinical psychologist, and aerospace physiologist. The objective is to prepare these officers to perform an actual mishap investigation.

USA, FAA, Civil Aeromedical Institute

Medical Aspects of Aircraft Accident Investigation (1 week) *Oklahoma City, Oklahoma*
To enable seminar participants to effectively, efficiently and safely participate in the investigation of aircraft accidents and incidents. To provide participants with a clear

understanding of the Office of Aviation Medicine's role, and their individual roles and responsibilities in aircraft accident investigation.

Other NATO Countries either have no formal human factor investigator training courses or did not report them to this working group.

ANNEX A

SURVEY

In order to establish a baseline framework WG 23 devised a questionnaire to find out how countries are presently conducting aircraft accident investigation and how data in particular human factors data is gathered. What follows are the collated answers to these questions.

QUESTION 1.

(A) What is your classification of aircraft accidents and incidents?
(B) At what level do you perform a full investigation?
(C) How do you differentiate accident and incident?

BELGIUM (BE)

(A) Class A, B, and C
Class A. Aircraft totally destroyed or deadly injuries in aircrew
Class B. Aircraft damaged but can be repaired in factory. Pilot injured and in hospital more than 21 days.
Class C. Aircraft can be repaired by local resources. Pilot less than 21 days in hospital.
(B) Class A or by order of the Chief of Staff of BAF
(C) Incident defined when no damage or injuries but circumstances could lead to a possible accident or hazard.

CANADA (CA)

(A) Categorized as accidents (category A,B,and C) and incidents:
Category A: aircraft destroyed or missing or fatal injury.(accident)
Category B: aircraft shipped to contractor for repair(accident)
Category C: repair beyond base level (accident)
Category D: repair of damage at base level (incident)
Category E: No damage to aircraft but potential risk existed for damage or injury (incident)
(B) All accidents category A, B, C
(C) As defined above in A).

FRANCE, AIR FORCE (FR, AF)

(A) Major: Loss of aircraft or death
Minor: Injuries to crew, damage to aircraft
Incident: others
(B) Major and minor accidents
(C) Differentiation based on severity of damage to the aircraft or injuries to persons.

FRANCE, ARMY (FR, AR)

(A) Accidents: Inflight, others
Incidents: Inflight, others
Incidents: major, minor

(B) For accidents and major incidents.

(C) Accident: fatality or destroyed aircraft
Incident: major injury or repairable aircraft

FRANCE, NAVY (FR, NA)

(A) Air or ground accident. Air or ground severe incident, and air or ground light incident.

(B) All accidents and incidents if cause is not obvious

(C) Accidents: event which causes either fatalities or damage to aircraft that cannot be repaired in Naval workshops.

GERMANY (GE)

(A) Aircraft Accidents category II and I, and aircraft incidents

(B) Category II and I. In exceptional circumstances in aircraft incidents.

(C) Differentiation based in degree of injuries sustained by pilot and passengers and amount of damage incurred.

ITALY (IT)

(A) Accidents class F.U.D., F.U.R., R3, incidents class R2 and R1.
F.U.D. : write off
F.U.R.: major damage/ partially recoverable
R3: depot maintenance required
R2: Wing level maintenance required
R1: Squadron maintenance required

(B) Full investigation in R3, F.U.R., and F.U.D

(C) R1 and R2 (maintenance is required at wing level)

NETHERLANDS (NE)

(A) Categorized as accidents or incidents

(B) Accidents only

(C) Accident if death or major injury (work loss of 30 days) or if aircraft is lost or repairs hours amount to greater than 800 hours.

NORWAY (NO)

(A) Class A and B : accidents
Class C, D, E: incidents

(B) Normally Class A and B, but also some class C which are high potential incidents

(C) By damage to aircraft and injury to personnel

PORTUGAL (PO)

(A) 5 categories of aircraft damage or bodily injury. Categories not specified.

(B) All accidents and incidents investigated.

(C) No injuries. Aircraft level I or II

SPAIN (SP)

(A) Categorized as major accidents and incidents. Major accident if >80% damage, mortal or injuries

(B) Board investigates accidents and eventually incidents

(C) Accident if damage to aircraft or injury to crew or passenger. Incident if risk exist for person or aircraft/material.

UNITED KINGDOM (UK)

(A) Accident: An occurrence involving an RAF aircraft which results in the aircraft sustaining category 4 or 5 or RAF personnel receiving fatal or major injuries.

Category 4: Aircraft not repairable on site , removed to repair depot

Category 5: Aircraft damaged beyond economic repair or is missing.

Incident: An occurrence involving an RAF aircraft which results in the aircraft sustaining category 1, 2, or 3 damage or in RAF personnel receiving minor or slight injury or which discloses a flight safety hazard or potential hazard.

Category 1: Damage is repairable on site. (First line maintenance)

Category 2: Damage is repairable on site . (Second line maintenance)

Category 3: Damage is repairable on site but assistance is required from salvage unit or contractor.

(B) For category 4 and 5.

(C) As above

UNITED STATES AIR FORCE (USAF)

(A) Class A mishaps: Total cost of $1,000,000.00 USD or more, or have a fatality or permanent total injury or have destruction of or beyond economical repair.

Class B mishaps: Total cost of $200,000.00 USD or more, but less than $1,000,000.00, or , a permanent partial disability or hospitalization of 5 or more personnel.

Class C mishaps: Total cost of $10,000.00 USD or more, but less than $200,000.00, or, an injury resulting in a lost workday (i.e.,8 hours or greater)

Class D mishaps: Total cost of $2,000.00 USD or more but less than $10,000.00, or, an injury resulting in loss of part of a workday or a nonfatal case without loss of workdays.

(B) All class A mishaps, most class B mishaps and some class C mishaps. Full investigation of class B and C mishaps are determined by the major command Commander of the aircraft being investigated.

(C) An incident is an event that has the potential in the future to cause an accident. Incidents are usually written up as a High Accident Potential (HAP) event.

UNITED STATES NAVY (USN)

(A) Class A, B, or C mishaps. Naval Aircraft Mishap: unplanned event or series of events directly involving Naval aircraft which result in any of the following: (1) damage to aircraft or property amounting to $10,000 USD or greater or (2) injury.

(B) All class A mishaps

(C) We do not use the terms accident vs. incident but use various categories of mishap (see appendix 4A)

O FIX WING COUNTRY	1990 HOURS	1991 HOURS	1992 HOURS	1993 HOURS	1994 HOURS	1995 HOURS	TOTAL HOURS
Spanish AF	30,208	31,373	30,981	33,940	34,352	33,132	193,986
Italian AF	53,653	55,642	52,951	57,835	50,989	49,072	320,142
Canadian Forces	155,543	147,485	135,425	132,031	122,456	98,345	791,285
German AF	39,822	48,349	42,215	33,899	30,625	23,408	218,318
Royal AF	434,468	394,266	369,529	344,959	320,507	299,066	2,162,795
French AF	216,167	191,889	192,362	185,621	179,369	170,898	1,136,306
US AF	2,116,274	2,360,024	1,714,675	1,599,701	1,391,529	1,358,972	10,541,175
Royal Navy	12,133	11,099	7,515	10,683	6,272	5,616	53,318
French Navy	49,707	47,516	45,902	46,782	46,520	44,713	281,140
US Navy	981,172	920,533	824,431	762,744	661,487	664,523	4,814,890
Royal Army	8,438	9,577	8,956	7,860	7,395	7,791	50,017
US Army	187,275	162,704	168,160	143,307	157,077	153,496	972,019
TOTALS	4,284,860	4,380,457	3,593,102	3,359,362	3,008,578	2,909,032	21,535,391

Helicopter COUNTRY	1990 HOURS	1991 HOURS	1992 HOURS	1993 HOURS	1994 HOURS	1995 HOURS	TOTAL HOURS
Spanish AF	9,221	8,779	9,711	9,173	9,537	11,160	57,581
Italian AF	22,937	19,950	21,354	22,286	24,865	23,070	134,462
Canadian Forces	71,407	73,810	66,974	70,031	67,241	57,142	406,605
German AF	176,523	191,146	174,474	151,110	138,693	100,994	932,940
Royal AF	72,531	67,751	70,370	66,578	66,150	67,103	410,483
French AF	26,047	21,001	23,470	23,711	23,111	23,471	140,811
US AF	65,823	65,480	65,216	63,653	61,546	61,505	383,223
Royal Navy	47,783	65,868	63,665	60,505	58,695	61,650	358,166
French Navy	21,901	22,651	16,712	21,075	21,537	22,689	126,565
US Navy	518,516	552,601	468,206	449,270	423,399	411,623	2,823,615
Royal Army	95,877	95,543	104,915	100,536	91,885	86,327	575,083
French Army	160,514	143,619	152,913	155,028	155,028	148,328	915,430
US Army	1,509,596	1,137,030	1,231,892	1,156,030	1,121,021	1,050,223	7,205,792
TOTALS	2,798,676	2,465,229	2,469,872	2,348,986	2,262,708	2,125,285	14,470,756

Summary COUNTRY	1990 HOURS	1991 HOURS	1992 HOURS	1993 HOURS	1994 HOURS	1995 HOURS	TOTAL HOURS
Spanish AF	99,788	102,301	96,760	101,734	107,496	114,820	622,899
Italian AF	159,427	153,074	139,803	150,585	141,741	131,007	875,637
Canadian Forces	274,390	266,081	239,975	234,702	221,751	180,580	1,417,479
German AF	364,937	388,178	352,271	296,929	274,766	202,492	1,879,573
Royal AF	645,208	582,642	555,811	518,327	484,685	461,861	3,248,534
French AF	375,825	332,509	340,977	334,575	321,753	306,409	2,012,048
US AF	3,365,785	3,684,741	2,787,917	2,526,079	2,256,424	2,200,388	16,821,334
Royal Navy	69,506	88,062	81,143	80,323	75,375	76,845	471,254
French Navy	85,501	84,217	75,898	80,339	82,723	80,440	489,118
US Navy	2,119,914	2,145,049	1,853,722	1,745,376	1,572,441	1,539,410	10,975,912
Royal Army	104,315	105,120	113,871	108,396	99,280	94,118	625,100
French Army	160,514	143,619	152,913	155,028	155,028	148,328	915,430
US Army	1,696,871	1,299,734	1,400,052	1,299,337	1,278,098	1,203,719	8,177,811
TOTALS	9,521,981	9,375,327	8,191,113	7,631,730	7,071,561	6,740,417	48,532,129

FIGHTERS COUNTRY	1990 RATE/ACC		1991 RATE/ACC		1992 RATE/ACC		1993 RATE/ACC		1994 RATE/ACC		1995 RATE/ACC		TOTAL RATE/ACC	
Spanish AF	4.97	(3)	9.65	(6)	10.70	(6)	1.71	(1)	1.57	(1)	4.25	(3)	5.39	(20)
Italian AF	10.86	(9)	5.16	(4)	7.63	(5)	5.68	(4)	7.59	(5)	5.10	(3)	7.13	(30)
Canadian Forces	8.43	(4)	2.23	(1)	7.98	(3)	6.13	(2)	9.36	(3)	15.94	(4)	7.29	(16)
German AF	2.02	(3)	2.69	(4)	0.74	(1)	4.47	(5)	1.90	(2)	6.40	(5)	2.75	(20)
Royal AF	6.51	(9)	8.29	(10)	2.59	(3)	2.81	(3)	7.14	(7)	5.23	(5)	5.48	(37)
French AF	6.74	(9)	4.18	(5)	4.79	(6)	4.79	(6)	3.35	(4)	5.36	(6)	4.90	(36)
US AF	3.72	(44)	2.54	(32)	3.27	(33)	3.01	(26)	3.61	(29)	2.56	(20)	3.12	(184)
Royal Navy	20.86	(2)	9.01	(1)	20.07	(2)	0.00	(0)	28.82	(3)	10.44	(1)	15.06	(9)
French Navy	21.59	(3)	14.23	(2)	22.58	(3)	0.00	(0)	6.82	(1)	30.68	(4)	15.97	(13)
US Navy	6.29	(39)	4.61	(31)	5.17	(29)	5.81	(31)	3.69	(18)	4.75	(22)	5.09	(170)
TOTALS	91.99	(125)	62.61	(96)	85.54	(91)	34.40	(78)	73.86	(73)	90.71	(73)	72.16	(535)

O FIX WING COUNTRY	1990 RATE/ACC		1991 RATE/ACC		1992 RATE/ACC		1993 RATE/ACC		1994 RATE/ACC		1995 RATE/ACC		TOTAL RATE/ACC	
Spanish AF	0.00	(0)	0.00	(1)	3.23	(1)	0.00	(0)	0.00	(0)	0.00	(0)	3.23	(2)
Italian AF	1.86	(1)	3.59	(2)	1.89	(1)	1.73	(1)	1.96	(1)	0.00	(0)	11.04	(6)
Canadian Forces	0.00	(0)	0.00	(0)	0.00	(0)	0.00	(0)	0.00	(0)	0.00	(0)	0.00	(0)
German AF	2.51	(1)	0.00	(0)	4.74	(2)	0.00	(0)	0.00	(0)	4.27	(1)	11.52	(4)
Royal AF	2.76	(12)	3.04	(12)	1.62	(6)	1.74	(6)	1.87	(6)	2.67	(8)	13.72	(50)
French AF	0.93	(2)	2.08	(4)	2.08	(4)	1.08	(2)	0.00	(0)	1.17	(2)	7.34	(14)
US AF	0.33	(7)	0.30	(7)	0.70	(12)	0.44	(7)	0.29	(4)	0.66	(9)	2.71	(46)
Royal Navy	8.24	(1)	0.00	(0)	0.00	(0)	0.00	(0)	0.00	(0)	0.00	(0)	8.24	(1)
French Navy	2.01	(1)	4.21	(2)	4.36	(2)	2.14	(1)	0.00	(0)	2.24	(1)	14.95	(7)
US Navy	1.12	(11)	1.09	(10)	1.70	(14)	0.52	(4)	0.45	(3)	0.75	(5)	5.64	(47)
Royal Army	11.85	(1)	0.00	(0)	0.00	(0)	12.72	(1)	0.00	(0)	0.00	(0)	24.57	(0)
US Army	0.53	(1)	1.23	(2)	2.97	(5)	0.70	(1)	0.00	(0)	0.65	(1)	6.09	(2)
TOTALS	32.15	(38)	15.54	(40)	23.29	(47)	21.07	(23)	4.57	(14)	12.42	(27)	109.04	(189)

Helicopter COUNTRY	1990 RATE/ACC		1991 RATE/ACC		1992 RATE/ACC		1993 RATE/ACC		1994 RATE/ACC		1995 RATE/ACC		TOTAL RATE/ACC	
Spanish AF	0.00	(0)	11.39	(1)	10.30	(1)	0.00	(0)	0.00	(0)	0.00	(0)	21.69	(2)
Italian AF	4.36	(1)	0.00	(0)	0.00	(0)	0.00	(0)	0.00	(0)	0.00	(0)	4.36	(1)
Canadian Forces	11.20	(8)	4.06	(3)	4.48	(3)	10.00	(7)	10.41	(7)	5.25	(3)	45.40	(31)
German AF	3.40	(6)	1.05	(2)	0.00	(0)	3.31	(5)	1.44	(2)	2.97	(3)	12.17	(18)
Royal AF	4.14	(3)	4.43	(3)	4.26	(3)	4.51	(3)	1.51	(1)	0.00	(0)	18.85	(13)
French AF	0.00	(0)	0.00	(0)	8.52	(2)	8.43	(2)	8.65	(2)	0.00	(0)	25.61	(6)
US AF	0.00	(0)	3.05	(2)	4.60	(3)	1.57	(1)	4.87	(3)	4.88	(3)	18.98	(12)
Royal Navy	4.19	(2)	6.07	(4)	0.00	(0)	4.96	(3)	3.41	(2)	1.62	(1)	20.25	(12)
French Navy	0.00	(0)	8.83	(2)	5.98	(1)	4.74	(1)	9.29	(2)	4.41	(1)	33.25	(7)
US Navy	3.09	(16)	3.44	(19)	2.56	(12)	4.01	(18)	1.65	(7)	1.70	(7)	16.45	(79)
Royal Army	6.26	(6)	5.23	(5)	3.81	(4)	1.99	(2)	4.35	(4)	1.16	(1)	22.80	(22)
French Army	1.25	(2)	2.09	(3)	0.00	(0)	0.65	(1)	0.65	(1)	1.35	(2)	5.97	(9)
US Army	1.99	(30)	4.05	(46)	1.38	(17)	1.90	(22)	1.87	(21)	0.86	(9)	12.05	145)
TOTALS	39.86	(74)	53.69	(90)	45.90	(46)	46.06	(65)	48.11	(52)	24.19	(30)	257.82	357)

Summary COUNTRY	1990 RATE/ACC		1991 RATE/ACC		1992 RATE/ACC		1993 RATE/ACC		1994 RATE/ACC		1995 RATE/ACC		TOTAL RATE/ACC	
Spanish AF	3.01	(3)	7.82	(8)	8.27	(8)	0.98	(1)	0.93	(1)	2.61	(3)	23.62	(24)
Italian AF	6.90	(11)	3.92	(6)	4.29	(6)	3.32	(5)	4.23	(6)	2.29	(3)	24.95	(37)
Canadian Forces	4.37	(12)	1.50	(4)	2.50	(6)	3.83	(9)	4.51	(10)	3.88	(7)	20.60	(48)
German AF	2.74	(10)	1.55	(6)	0.85	(3)	3.37	(10)	1.46	(4)	4.44	(9)	14.41	(42)
Royal AF	3.72	(24)	4.29	(25)	2.16	(12)	2.32	(12)	2.89	(14)	2.81	(13)	18.19	(100)
French AF	2.93	(11)	2.71	(9)	3.52	(12)	2.99	(10)	1.86	(6)	2.61	(8)	16.62	(56)
US AF	1.52	(51)	1.11	(41)	1.72	(48)	1.35	(34)	1.60	(36)	1.45	(32)	8.75	(242)
Royal Navy	7.19	(5)	5.68	(5)	2.46	(2)	3.73	(3)	6.63	(5)	2.60	(2)	28.31	(22)
French Navy	4.68	(4)	7.12	(6)	7.91	(6)	2.49	(2)	3.63	(3)	7.46	(6)	33.28	(27)
US Navy	3.11	(66)	2.80	(60)	2.97	(55)	3.04	(53)	1.78	(28)	2.21	(34)	15.90	(296)
Royal Army	6.71	(7)	4.76	(5)	3.51	(4)	2.77	(3)	4.03	(4)	1.06	(1)	22.84	(24)
French Army	1.25	(2)	2.09	(3)	0.00	(0)	0.65	(1)	0.65	(1)	1.35	(2)	5.97	(9)
US Army	1.83	(31)	3.69	(48)	1.57	(22)	1.77	(23)	1.64	(21)	0.83	(10)	11.34	(155)
TOTALS	49.95	(237)	49.04	(226)	41.73	(184)	32.60	(166)	35.84	(139)	35.62	(130)	244.77	(1082)

QUESTION 3.
What percentage of these accidents do you attribute after investigation to Human Factors?

	1994	1993	1992	1991	1990
BELGIUM	100	62	50	44	60
CANADA	72	83	90	81	95
FRANCE AF	100	90	40	100	60
FRANCE ARMY	--	100	--	66	100
FRANCE NA	67	100	83	83	25
GERMANY	50	90	100	83	90
ITALY	70	62	52	60	53
NETHERLANDS	50	0	40	50	50
NORWAY			100		100
PORTUGAL	43	23	21	20	46
SPAIN	54	54	54	54	54
UNITED KINGDOM	50	44	33	27	33
USAF	60	52	62	54	61
USN	100	100	100	100	100

QUESTION 4.
What is the number of aircraft incidents reported per year for:

	1994	1993	1992
BELGIUM	10	8	-
CANADA	1957	2163	2200
FRANCE, AF	800	900	-
FRANCE, NAVY	303	243	-
FRANCE,ARMY	91	91	-
GERMANY	2521	2593	-
ITALY	(0.45)	(0.55)	-
NETHERLANDS	56	76	-
NORWAY	657	620	-
PORTUGAL	20	20	-
SPAIN	500	500	-
UK	2520	3126	-
USAF	137	170	-
USN	N/A	N/A	N/A

QUESTION 5.
Are there habits, environmental or idiosyncratic aspects of life in your country which may have an influence on human factors consideration of aircraft accidents? If yes specify.

PORTUGAL
Work overload, stress, family absence, alcohol

NETHERLANDS
No

FRANCE AF
No

FRANCE NA
No

FRANCE AR
No

CANADA
Yes, " Can do attitude". An attitude that leads personnel to never refuse to accomplish a mission despite less resources, less personnel, below standard equipment, etc. An attitude that the mission will be done no matter what. This attitude is prevalent in the Canadian Forces.

GERMANY
No

US NAVY
No

BELGIUM
Cloudy environment
Presence of power pylons, towers and voltage lines

ITALY
No

U.K.
Not known

USAF
Competitiveness and the desire to push oneself too close to one's physiological limits.

NORWAY
No

QUESTION 6.

(A) Do you have a human factor accident investigation protocol currently used in aircraft accident investigation?

(B) How do you categorize aircraft accident causality/ human factors?

PORTUGAL

(A) Yes
(B) Crew error, maintenance error, organizational fault, others.

NETHERLANDS

(A) Yes
(B) Stress, overload, disorientation, psychological fitness, physical fitness

SPAIN

(A) No
(B) H/F: Medical/Pathological, Physiological/Environment, Engineering, Psycho/Behavior, Operational, Supervision.

FRANCE AF

(A) No
(B) Nonhuman Factors
Human Factors: Medical, Physiological, Human Error (sleepiness, faults, violations, cooperation, work, systemic failure).

FRANCE NA

(A) No

(B) Lifestyle, physical failure, phycological failure, breach of discipline, lack of judgment, lack of technical knowledge, mutual misunderstanding, breach of operating procedures, others.

FRANCE AR

(A) No

(B) Categorization is done by flight surgeon

CANADA

(A) Yes

(B) 6 Main categories: Personnel, Materiel, Environment, Operational, Undetermined and Unidentified FOD (Foreign object damage).

Personnel cause factors are then subdivided in 5 subcategories of: (a) Human Interaction, (b) Physical and/or Physiological Factors, © Psychological/Behavioral, (d) Pathological, (e) Pharmacological/Toxicological. Each subcategory is further subdivided in many sub-subcategories.

GERMANY

(A) Yes

(B) (1) Personnel-Aircrew

(2) Personnel-Technical personnel

(3) Personnel-Supervision

US NAVY

(A) Yes

(B) See enclosed appendix

BELGIUM

(A) No

(B) --

ITALY

(A) No

(B) --

U.K.

(A) Yes see attachment B-1

(B) See attachment A-3

USAF

(A) Yes computerized format not easily reproduced on paper

(B) See attachment

NORWAY

(A) No

(B) --

QUESTION 7.

(A) What is the composition of the investigation board for a major accident?

(B) Are these members full time safety accident investigation personnel (permanent board) or are they selected ad Hoc? and

(C) Who is responsible for the investigation of human factors (pilot, medical, psychologist, physiologist...)?

BELGIUM

(A) Chairman, pilot, maintenance, medical, legal member

(B) The chairman, pilot, and maintenance officers are full time members the medical member is selected ad hoc

(C) Medical member

CANADA

(A) Board president (senior officer-pilot), pilot current on type, flight surgeon, maintenance officer with the help of two flight safety investigators acting as advisors to the board.

(B) Selected ad Hoc

(C) Flight Surgeon with help of experts from the Defense and Civil Institute of Environmental Medicine.

FRANCE, AF

(A) President (pilot), pilot (current on type of aircraft),engineer, medical member, experts if required.

(B) Selected ad Hoc

(C) Institute of aerospace medicine, + ergonomist + psychologist.

FRANCE, AR

(A) Board president, pilot, engineer, flight surgeon

(B) Selected ad Hoc but not working in the concerned squadron

(C) Medical Officer

FRANCE, NA

(A) Head of board (senior officer-pilot), pilot current on type, maintenance officer, medical member

(B) Selected ad Hoc

(C) Medical officer in collaboration with pilot

GERMANY

(A) Chairman, accident investigator officer, engineer, flight surgeon, user representative, aviation psychologist, others if required

(B) Chairman , accident investigator officer permanent members others selected ad Hoc.

(C) responsibility of Division IV of GAF IAM

ITALY

(A) President (pilot), flight safety officer (experience on type), technical officer, flight surgeon, administration officer, air traffic controller, other if required.

(B) ad Hoc

(C) Flight surgeon

NETHERLANDS

(A) Full time president, president, pilot, medical member, technical member, psychologist, secretary, specialists

(B) Full time president only, others selected ad hoc.

(C) Medical member and aviation psychologist.

NORWAY

(A) President (pilot major or above), operations officer(flight safety officer), technical officer, medical doctor, pilot member (same rank and experience level as mishap pilot), police

(B) Members drawn ad Hoc from a pool of officers with accident investigation education.

(C) Medical doctor

PORTUGAL

(A) Board president (pilot),1 pilot (HF), 1 maintenance, 1 environment, 1 coordinator, 1 secretary, 1 medical member (non-permanent)

(B) Full time

(C) A pilot who has been trained appropriately

SPAIN

(A) President, pilot member, medical member, engineer, lawyer, secretary, homebase delegate, technicians if required

(B) Full time president and secretary only

(C) Medical member of the board.

U.K.

(A) President (Wg Cdr or Sqn Ldr), 1 DR. Flt Lt specialist. engineer and aircrew.

(B) ad Hoc

(C) Flight Surgeon and psychologist.

USAF

(A) Board president (Colonel), investigating officer (Capt/Major pilot) , pilot member (current on type), flight surgeon (Capt/Major/LtCol), maintenance officer,others as determined by the board president such as physiologist, human factor specialist, etc.

(B) ad Hoc

(C) HQ AFSA/SEL Kirkland AFB is ultimately responsible. We use flight surgeons, physiologist and psychologist to investigate human factors mishaps.

US NAVY

(A) Senior member (pilot) graduate of aviation safety officer course, aviation safety officer, maintenance officer, operations officer, flight surgeon.

(B) ad Hoc

(C) Flight surgeon

QUESTION 8.

(A) How long does this board spend performing a full investigation for a major accident.

(B) Is there any deadline for completion? C) Is additional time spent on a part time basis?

BELGIUM

(A) 2-3 months
(B) 90 days after the accident
(C) No

CANADA

(A) 14 days
(B) 14 days but extension may be granted
(C) Yes by the Directorate of Flight Safety

FRANCE, AF

(A) 2-3 months average
(B) No
(C) Yes

FRANCE, NA

(A) 10 days
(B) Yes
(C) Extension to the 10 days limit may be granted

FRANCE, AR

(A) Between 2 months to a year
(B) No deadline
(C) Yes time determined by board

GERMANY

(A) 3-5 months
(B) The report must be produced within 30 days of the accident
(C) Yes

ITALY

(A) 3 months
(B) 3 months, can be extended
(C) Yes

NETHERLANDS

(A) 75 working days average
(B) Deadline 1 year
(C) Yes

NORWAY

(A) 3-4 weeks
(B) No
(C) If needed

PORTUGAL

(A) No time
(B) No deadline
(C) No

SPAIN

(A) Not determined
(B) 45 days
(C) Not determined

U.K.

(A) 3-5 months
(B) No but Boards are expected to treat task as full time
(C) Only if board is utilizing specialist opinion from industry

USAF

(A) About 30 days
(B) About 30 days
(C) May be

USN

(A) As much time as necessary
(B) Report must be sent within 30 days
(C) Yes as needed

QUESTION 9.

(A) Who performs the autopsy?
(B) Does this include a full neuropathological review?
(C) Does the pathologist have a background in aerospace pathology ?

BELGIUM

(A) BAF Anatomo-pathologist
(B) Yes
(C) Yes

CANADA
- (A) Civilian pathologist
- (B) No
- (C) No, but pathologist assisted by qualified flight surgeon

FRANCE, AF
- (A) Medical doctor of the French AF
- (B) No
- (C) Not always

FRANCE, NA
- (A) Civilian doctor appointed by judge
- (B) Possibly
- (C) Generally not

FRANCE, AR
- (A) Civilian procedure
- (B) Not systematically
- (C) Generally not

GERMANY
- (A) An official medico-legal expert
- (B) Yes, if brain mass is found
- (C) Yes

CANADA
- (A) Civilian pathologist
- (B) No
- (C) No, but pathologist assisted by qualified flight surgeon

GERMANY
- (A) An official medico-legal expert
- (B) Yes, if brain mass is found
- (C) Yes

ITALY
- (A) Civilian pathologist
- (B) No
- C) No

NETHERLANDS
- (A) Military pathologist
- (B) Unknown
- (C) No

NORWAY
- (A) Regional civilian pathologist with the assistance of a doctor from IAM
- (B) Yes
- (C) The doctor from IAM has.

PORTUGAL

(A) Civilian medical authorities
(B) Yes
(C) No

SPAIN

(A) Coroner (civilian or military)
(B) Yes if performed in AF hospital
(C) No, if performed out of AF hospital

U.K.

(A) RAF Aviation pathologist
(B) Yes
(C) Yes

USAF

(A) A local coroner usually with the help of a pathologist from the Armed Forces Institute of Pathology (AFIP)
(B) AFIP does
(C) Yes

USN

(A) Armed Forces Institute of Pathology
(B) Yes
(C) Yes

QUESTION 10.

(A) Does your nation maintain a computerized database to analyze human factors causality of aircraft accident?
(B) Where is the database maintained?

BELGIUM

(A) No

CANADA

(A) No, but common database of all cause factors
(B) Directorate of Flight Safety

FRANCE, AF

(A) Yes
(B) At IMASSA. Maintained by medical personnel. Summarized database is filed by safety HQ

FRANCE, NA

(A) Yes
(B) Safety personnel

FRANCE, AR

(A) Yes
(B) Air Safety Council

GERMANY

(A) Yes
(B) Safety personnel

ITALY

(A) No

NETHERLANDS

(A) No
(B) By safety personnel

NORWAY

(A) No

PORTUGAL

(A) Yes
(B) By safety and medical personnel

SPAIN

(A) Common database (all factors analyzed)
(B) Safety Office

U.K.

(A) Yes. However detailed analysis of HF causality only available from July 93. All accidents prior to this date were attributed to aircrew error.
(B) Maintained at MOD IFS (RAF) by Flight safety personnel.

USAF

(A) Yes
(B) Air Force Safety Agency Headquarters (HQ AFSA), Kirtland AFB, New Mexico.

USN

(A) Yes
(B) Naval Safety Center

QUESTION 11.

Is there an anonymous reporting system of any kind related to aircraft incidents?

Belgium	No
Canada	Yes
France, AF	Yes
France,AR	Yes
France,NA	No
Germany	No
Italy	No
Netherlands	Yes
Norway	Yes
Portugal	Yes
Spain	Yes
United Kingdom	Yes
US Navy	Yes
USAF	No

QUESTION 12.

(A) Do you think the Human Factors Database currently in use in your country is sufficient for:

PORTUGAL	YES	NO
Basic Database	X	
User acceptance/ease of use	X	
Inter-operability with:		
- NATO countries		X
- different branches or services		X
Includes most of all human factors	X	
Extracting appropriate conclusions		X

NETHERLANDS

No answer

SPAIN	YES	NO
Basic Database	X	
User acceptance/ease of use	X	
Interoperability with:		
- NATO countries		X
- different branches or services		X
Includes most of all human factors	X	
Extracting appropriate conclusions	X	

FRANCE, AF	YES	NO
Basic Database	X	
User acceptance/ease of use	X	
Inter-operability with:		
- NATO countries	X	
- different branches or services	X	
Includes most of all human factors	X	
Extracting appropriate conclusions	X	

FRANCE, NA	YES	NO
Basic Database	X	
User acceptance/ease of use	X	
Inter-operability with:		
- NATO countries	-	
- different branches or services	-	
Includes most of all human factors	X	
Extracting appropriate conclusions	X	

FRANCE, AR
No answer

CANADA	YES	NO
Basic Database		X
User acceptance/ease of use		X
Inter-operability with:		
- NATO countries		X
- different branches or services		X
Includes most of all human factors		X
Extracting appropriate conclusions		X

GERMANY	YES	NO
Basic Database	X	
User acceptance/ease of use		X
Inter-operability with:		
- NATO countries		X
- different branches or services	X	
Includes most of all human factors	X	
Extracting appropriate conclusions		X

USN	YES	NO
Basic Database	X	
User acceptance/ease of use	X	
Inter-operability with:		
- NATO countries		X
- different branches or services		X
Includes most of all human factors	X	
Extracting appropriate conclusions	X	

BELGIUM	**YES**	**NO**
Basic Database		X
User acceptance/ease of use		X
Inter-operability with:		
- NATO countries		X
- different branches or services		X
Includes most of all human factors		X
Extracting appropriate conclusions		X

ITALY	**YES**	**NO**	
Basic Database		X	
User acceptance/ease of use		X	
Inter-operability with:			
- NATO countries			X
- different branches or services		X	
Includes most of all human factors		X	
Extracting appropriate conclusions		X	

UK	**YES**	**NO**
Basic Database	X	
User acceptance/ease of use	X	
Inter-operability with:		
- NATO countries		X
- different branches or services		X
Includes most of all human factors		X
Extracting appropriate conclusions		-

USAF	**YES**	**NO**
Basic Database	X	
User acceptance/ease of use		X
Inter-operability with:		
- NATO countries		X
- different branches or services		X
Includes most of all human factors	X	
Extracting appropriate conclusions	X	

NORWAY	**YES**	**NO**
Basic Database		X
User acceptance/ease of use		X
Inter-operability with:		
- NATO countries		X
- different branches or services		X
Includes most of all human factors		X
Extracting appropriate conclusions		X

(B) When was this database developed? How many database items are included?

PORTUGAL	1990	300
NETHERLANDS	---	---
SPAIN	1994	600
FRANCE, AF	1993	100
FRANCE, NA	1993	9
FRANCE, AR	----	---
CANADA	----	---
GERMANY	1991	100
USN	1954	???
BELGIUM	----	---
ITALY	----	---
UK	---	---
USAF	1971	950
NORWAY	---	---

QUESTION 13.
Do you feel there is a need for a complete Human Factors database protocol with inter operability requirements?

BELGIUM
Definitely yes

CANADA
Definitely yes

FRANCE, AF
Definitely yes

FRANCE, AR
Probably yes

FRANCE, NA
Definitely yes

GERMANY
Probably yes

ITALY
Definitely yes

PORTUGAL
Probably yes

NETHERLANDS
Definitely yes

NORWAY
Definitely yes

SPAIN
Definitely yes

U.K.
Definitely no

USAF
Definitely yes

QUESTION 14.
Does your country run any course or training program in Aircraft accident investigation, Human Factors, Situational awareness ,etc. for 1. aviators , 2. Aviation Medical Personnel, 3. Aviation Ground Support, 4. commanders/supervisors? Who is responsible for such course? Give detailed information these training programs, syllabus, time invested in the course...

BELGIUM

Each wing has a safety pilot who is a graduate of the Institut Français de Sécurité de vols: 5 weeks

Investigation board members receive 11 weeks of training from University of Southern California.

Pilot officers from tactical branch of Air staff HQ follow NATO flying supervisors course, UK.

Flight surgeons: no course

The Belgian Air Force does not run any courses or training programs such as mentioned above.

CANADA

Aviators: Each squadron has a pilot in the position of UFSO. They receive unit flight safety officer course 1 week in duration given by the Directorate of Flight Safety. Each wing has a WFSO wing flight safety officer that has received a one week course for WFSO given by DFS

Aviators receive no human factors training but some may receive crew resource management. All receive aeromedical training through our school of aeromedical training , 2 days.

Flight Surgeons: receive one week of aircraft accident investigation and human factors as part of their flight surgeon's course.

Ground support: no accident investigation, some receive unit flight safety course 1 week and some bases offer a Human Performance Training for maintenance personnel. The forces are looking at making this course available for all Air Force maintenance personnel.

Commanders and supervisors: no flight safety course, no human factors training, no supervisors course but they do have a one week air squadron commanders seminar.

Flight Safety Officers of the directorate of Flight Safety receive aircraft accident investigation course at the University of Southern California (USC), Cranfield U.K., Tempe Arizona.

FRANCE, AF
Yes for aviators and medical personnel by Flight safety and IMASSA

FRANCE, NA
Yes, aviators.
Commanders and supervisors: civilian Institute of Flight Safety

FRANCE, AR

GERMANY
Aviators : FSO basic course: 4 weeks
Flight Safety Officer course: 2 months
Ground personnel: flight safety for NCO: 4 weeks. Flight safety for technical officers and quality control personnel: 4 weeks
Supervisors: flight safety seminar: 1 week

ITALY
Yes 1,2,3,4, from Flight Safety inspectorate of IAFHQ
Accident Prevention Course: 14 days; participants are usually young officers coming from all specialties.
Accident Investigation Course: 60 days; participants are officers of Armed Forces and State Corps.

NETHERLANDS
Yes aviators : responsibility of flight safety
Medical personnel: responsibility of ground safety
Commanders/supervisors: responsibility of operations

NORWAY
Our main AAI education is done in USA, but we give a 1 week course on Norwegian rules for AAI. This course is given by the inspectorate of flight safety.

PORTUGAL
Yes for aviators, medical, ground support and supervisors.

SPAIN
Aircraft accident investigation course for aviators (slots available for engineers and flight surgeons)

US ARMY
Aviation Safety Officer Course: 6 week course for aviators (1 week of accident investigation
Army Accident Investigation Course: 1 week course for aviation ground support personnel.
Army Flight Surgeon Course: provides basic instruction on accident investigation for flight surgeons
Crash survival Investigation School: 2 week courses for selected aviation safety officers and flight surgeons.

The first three courses are available through the U.S. ARMY Safety Center. The last one is available through the international Center for Safety Education, Phoenix, Arizona.

U.K.
Current courses include: Flight safety Course, Flying authorizers course, Implementation of crew resource management, specialist in aviation medicine and aircraft accident investigation.

USAF
Yes for all groups mentioned. Class conducted by HQ AFSA and some by the School of Aerospace medicine.

USN
Aviators: Naval post graduate school

QUESTION 15.
Have you ever implemented STANAG 3531 or 3318 (aeromedical aspects of AAI)?

PO	Yes
NE	Yes
SP	Yes
FR, AF	Yes
FR, NA	No
FR, AR	No
CA	Yes
GE	Yes
USN	---
BE	Yes
IT	Yes 3531
U.K.	No
USAF	Do not know
NO	Yes

QUESTION 16.
How do you communicate significant safety/human factors findings?

BELGIUM
Monthly newsletter

CANADA
Safety messages, bulletins, flight safety publication: every two months, posters, annual briefing, videos.

FRANCE, AF
Internal communication, flight safety publications: every 3 months

FRANCE, AR
Flight safety meetings

FRANCE, NA
Navy safety monthly bulletin

GERMANY
Final statement of report of major incidents. Final report of accidents. Monthly publication of safety information, safety magazine, videos.

ITALY
Official channels and flight safety publication

NETHERLANDS
National safety magazine, briefings, international safety reports

NORWAY
Our safety magazine

PORTUGAL
Briefings,posters, monthly report

SPAIN
Safety bulletins, internal reports, safety control tours

U.K.
Air Clues (flight safety magazine), feedback, aircraft accident reports and various flight safety publications.

USAF
Message

USN
Official messages, safety publications, magazine, quarterly newsletter.

QUESTION 17.

(A) Do you record all survivor data? B) How do you collect it? C) Does this include a neurological review and imaging?

BELGIUM

(A) Yes
(B) By medical investigator
(C) Yes

CANADA

(A) Yes
(B) Interview ,physical exam and toxicology
(C) Only if indicated

FRANCE, AF

(A) Yes
(B) Collected in board of inquiry reports
(C)

FRANCE, AR

(A) No (B) (C)

FRANCE, NA

(A) Yes
(B) Medical exam
(C)

GERMANY

(A) Yes
(B) Medical exam
(C) Yes

ITALY

(A) Yes
(B) There is a form included in AF flight safety investigation directive
(C) No

NETHERLANDS

(A) Yes
(B) accident reports
(C) --

NORWAY

(A) Yes
(B) In files at the IAM
(C) Yes

PORTUGAL

(A) Yes
(B) Interview
(C) Yes

SPAIN

(A) No (B) (C)

U.K.

No answer

USAF

No answer

USN

(A) Yes

(B) Medical exam, toxicology 72 hour narrative history of all activities up to the time of the mishap is obtained.

(C) As required

QUESTION 18.
Are crew helmets retained and examined?

BELGIUM
Yes, photographed only

CANADA
Yes, all life support equipment examined and tested as necessary at the Aerospace Life Support Sector of our Defense and Civil Institute of Environmental Medicine.

FRANCE, AF
After bail out

FRANCE, AR
No

FRANCE, NA
Yes

GERMANY
Yes, subsequent ejection helmet is examined and removed from service.

ITALY
Yes, external inspection only

NETHERLANDS
No

NORWAY
Yes by a PE officer which analyze the damage to the helmet.

PORTUGAL
Yes, helmets photographed and tested in laboratory.

SPAIN
Occasionally

U.K.
No answer

USAF
No answer

USN

Yes , an engineering investigation will be conducted on the life support equipment used in the mishap. All recovered aircrew helmets examined and tested by the Naval Air Development Center.

QUESTION 19.
Is the information provided to the medical investigator privileged in any way ?

BELGIUM

The investigation dossier is sent to the legal authority

CANADA

Yes, medical investigation is for medical purposes only.

FRANCE, AF

No

FRANCE, AR

No

FRANCE, NA

Medical investigation report is for medical purposes only

GERMANY

Information gathered in the course of an investigation can be used for sanction and punishment

ITALY

No

NETHERLANDS

Yes, information cannot be used for sanctions or punishment

NORWAY

Kept in a sealed envelope and can be only opened by a medical doctor.

PORTUGAL

Yes, used for safety purposes only.

SPAIN

Board of Inquiry information is not privileged. Information gathered by the safety team is privileged

U.K.

No

USAF
Yes, certain aspects of the medical deliberations and the witness interviews (changes in privilege may be forthcoming)

USN
Yes information is privileged

QUESTION 20.
Can you give a name of a person responsible for human factors investigation/analysis, who could act as point of contact?

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Lieutenant Colonel Gilbert Brisaert, MD
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Raketstraat 70. 1130 Evere. Brussels. Belgium
Tel: 00-32-2-7015480

CANADA
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Directorate of Flight Safety 3-5
Air Command Headquarters
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R3J 0T0
Tel: (204) 833-5454
Fax: (204) 833-6983

FRANCE, AF
Lt Col Rivoallan
Flight safety Organization. France
Tel.: 45523169
Fax: 45521175

FRANCE, AR
MC Seynaeve
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Fax: 42921921

FRANCE, NA
MCS Courcoux

GERMANY
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GAF Institute Aviation Medicine. Division V Forensic Medicine
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ITALY
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NETHERLANDS
AGW Guus v d Eizen
NORWAY
No answer

PORTUGAL
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CMA Paco do Luminar, 1600 Lisbon, Portugal
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UNITED KINGDOM
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DRA. Centre for Human Sciences. Farnborough
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USAF
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USA

USN
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Naval Safety Center Code 141
NAS Norfolk, Virginia 23511
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CONCLUSIONS AND RECOMMENDATIONS

It is concluded that:

a. The concept of an internationally accepted common human factors database implies the presence of an internationally accepted framework.

b. The development of a comprehensive NATO database was premature at the present time due to international differences in aircraft accident investigation methods, terminology and categorization.

c. Any human factors database produced may be rendered obsolete with an increase in the understanding of human factors contributions to aircraft accidents and by advances in database design with future technology to enhance the retrieval of textual material.

d. Increasing multinational military operations can be expected to lead to the need to analyze the cultural, linguistic, organizational, and operational contributions to aircraft accidents.

e. The collection of human factors data varies from investigation to investigation both in the range of human factors considered and in the documentation of this material in the final accident report as accident investigators received variable formal training in this aspect of accident investigation.

f. STANAG 3318, which delineates the aeromedical aspects of aircraft accident investigation, does not presently reflect the recognized importance of human factors data collection and analysis.

g. Human factors analysis from a maximum number of military and civil aircraft accidents and incidents is required to provide sufficient evidence to introduce pro-active preventative measures for improved flight safety.

It is recommended that:

a. A forum of international specialists be convened for the discussion of the human factors contribution to aircraft accidents in order to introduce improvements in flight safety and accident prevention.

b. Research be undertaken to create a comprehensive human factors terminology, complete with unambiguous definitions of the terms, suitable for the international collection of human factors accident data.

c. International co-operation and information exchange between the civil and military aviation authorities of NATO countries be enhanced to increase the amount of human factors data from aircraft accidents available for analysis.

d. All sources of human factors data should be exploited, including information available from flight simulators, confidential aircrew reports and aircraft incidents.

e. The training of international human factors investigators ensures commonality of approach to accident investigation with uniformity of accident reporting and data handling.

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14. Abstract

The overall goal of Working Group 23 was to improve the application of human factors analysis to operational enhancement and mishap prevention programs.

Through different chapters, a variety of related topics were discussed in relation to the current status and approaches to aircraft accident/incident investigation, taking into account the human factors involved, procedures, categorization, tabulation and analysis. In addition, following a questionnaire which was widely distributed among all NATO countries, current data concerning the number of accidents, human factors studies, organizational aspects and the data collection were compiled and discussed.

Also the possible approaches to conceptual models were described as a potential framework for the support and organisation of the principles and topics to be included in human factors/aeromedical data base.

The Working Group reviewed current training programmes and discussed a common approach, in which human factors play a definite role.

Examples of data bases currently in use are enclosed.

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